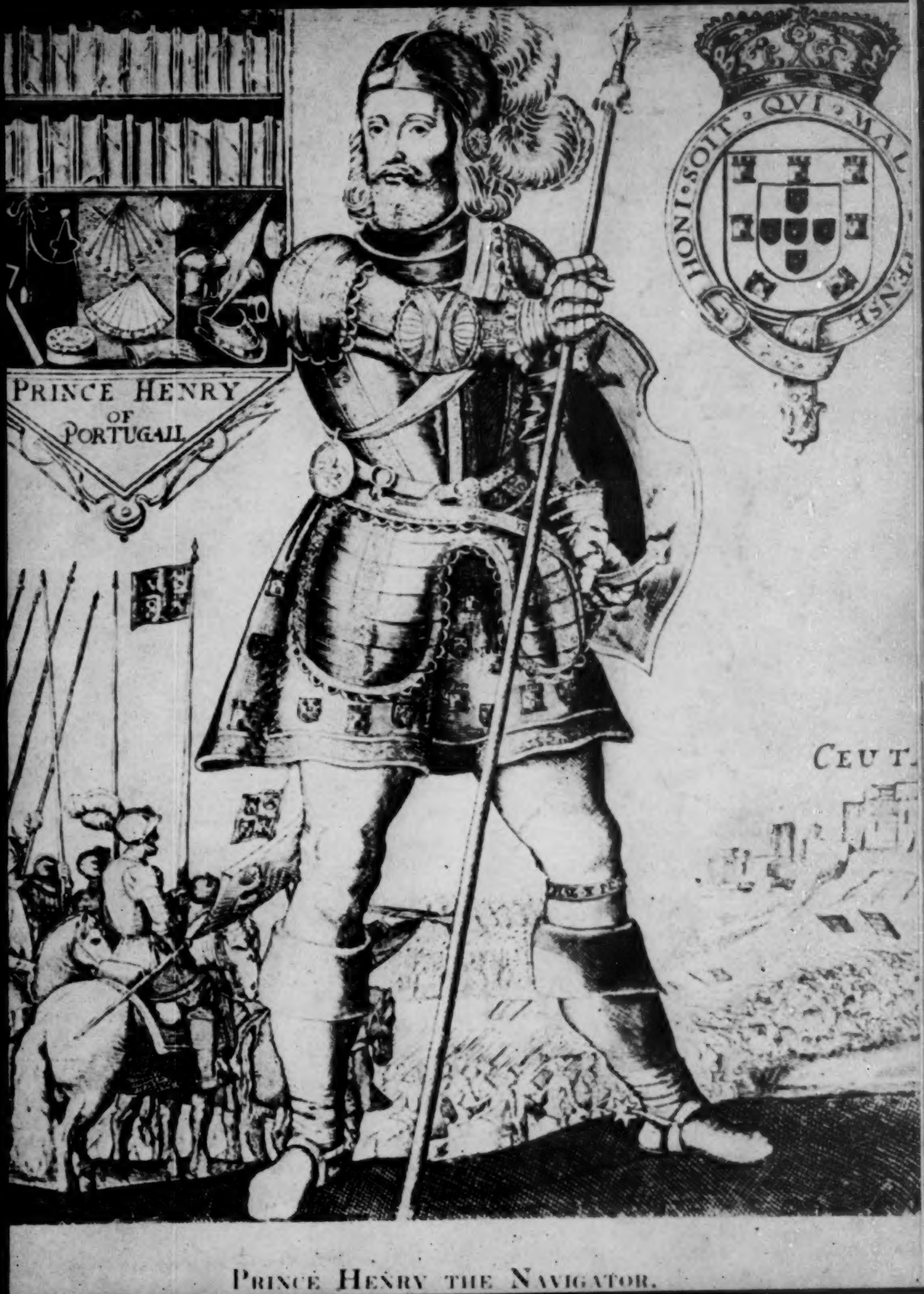
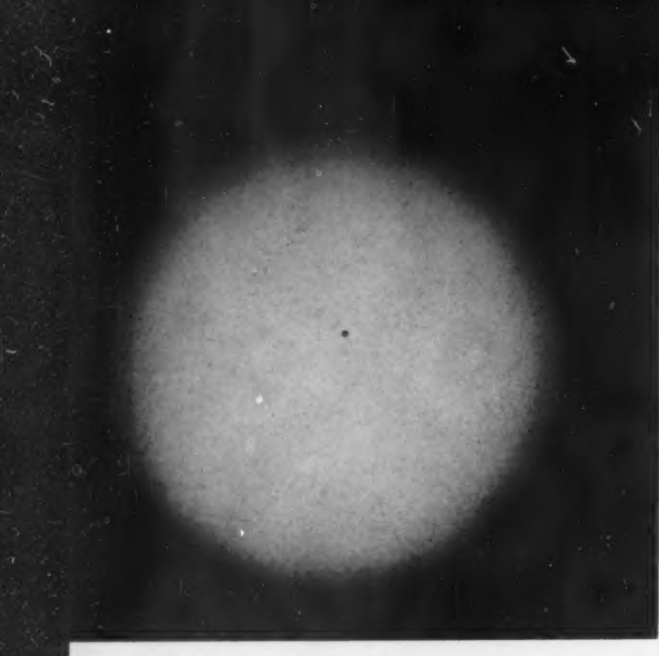


PRINCE HENRY THE NAVIGATOR.



ACTION ON THE SUN

AMATEUR ASTRONOMERS may not have noticed brief items in the newspapers of Monday morning, August 9th, to the effect that sunspots had blacked out short-wave radio communication between the United States and Europe the previous evening. Columbia's short-wave listening station reported a complete cessation of reception from all radio stations on the Continent starting at 5:00 p.m. E.W.T., on Sunday. The London overseas radio was forced off the air for the first time in CBS monitoring history.

Many who did read this news may have taken time Monday to observe the sun, when projection of its image through binoculars (see "Observer's Page" this month) showed one rather mediocre spot near the center of the solar disk. It is by no means proven that this spot caused the radio interruptions, nor that the connection between sunspots and terrestrial phenomena of this sort is direct, but this occasion favored such an interpretation.

The above photograph was provided (on extremely short notice) by the United States Naval Observatory, where the sun is photographed daily, and its spots measured and counted. With this picture, taken at 10:37:25 E.S.T., August 9th (the day before the radio blackout began), Mrs. L. T. Day kindly furnished the information that the nearly central spot has an area of 3½ square degrees, covers 170 millionths of the visible hemisphere, is in heliographic latitude +12 degrees, and is three degrees west of the central meridian.

The Department of Terrestrial Magnetism of the Carnegie Institution of Washington reports:

"Magnetic disturbance of moderate intensity began approximately at 20 hours E.W.T. on August 7th with small, but rapid oscillations. It reached its peak of disturbance between 20 and 23 hours E.W.T. on August 8th, after which it declined rather rapidly. The disturbance was the most intense experience since October 29, 1942."

No aurorae have been reported to us, but on Tuesday evening radio stations were again having difficulty hearing London broadcasts. The path of sunspots across the sun during September carries them near its center, and amateurs may wish to be particularly watchful of the night skies for possible auroral displays.

Sky and TELESCOPE

The Editors Note . . .

LAST month in this column there appeared a partial list of articles on astronomy and related subjects which have been published recently in other periodicals. To the layman who is interested in keeping abreast of modern developments in this science, such a list may prove helpful. The selection is purely arbitrary, and the list must not be considered complete.

Astrophysical Journal (University of Chicago Press). Jan. '43 is Vol 97, No. 1.
Observations of the Light of the Night Sky with a Photoelectric Photometer. C. T. Elvey. Jan. '43.
A Spectrographic Study of Meteorites. W. W. A. Johnson and Daniel P. Norman. Jan. '43.
Henry Gordon Gale. Henry Crew. March '43.
Arthur Bambridge Wyse. W. H. Wright. March '43.
The Direction of Rotation in Spiral Nebulae. Edwin Hubble. March '43.
Nova Ophiuchi of 1604 as a Supernova. W. Baade. March '43.

Publications of the Astronomical Society of the Pacific (A.S.P., San Francisco). Oct. '42 is Number 320.
Clusters of Nebulae. F. Zwicky. Oct. '42.
Molecules: Their Role in Astronomy. P. Swings. Dec. '42.
The Expanding Shell Around Nova Herculis. W. Baade. Dec. '42.
The Sun in Action. Seth B. Nicholson. Feb. '43.

Journal of the Royal Astronomical Society of Canada (Toronto, Ont.). Jan. '43 is Vol. XXXVII, No. 1.
Amateur Seismology in the Making. Edward Mantle. Feb. '42.
The Astrophysical Observatory of the California Institute of Technology. J. A. Anderson. May-June '42.
Does Anything Ever Happen on the Moon? Walter H. Haas. July to Nov. '42.
Early American Astronomers. S. A. Mitchell. Oct. '42.

(*Continued next month*)

VOL. II, NO. 11
WHOLE NUMBER 23

SEPTEMBER, 1943

CONTENTS

COVER: Prince Henry of Portugal, called The Navigator, after a print by Simon de Passe. (See "In Focus.")

BACK COVER: The region of the Milky Way surrounding Antares and the head of the Scorpion, photographed by Frank E. Ross at Lowell Observatory, Flagstaff, Ariz., May 18, 1931. The exposure time was three hours, using a Ross-Fecker lens of 5-inch aperture, 35-inch focus, now the property of Mount Wilson Observatory. The print from which this engraving is slightly enlarged is Plate 2 of the "Atlas of the Northern Milky Way," by Frank E. Ross and Mary R. Calvert, published by the University of Chicago Press, 1934.

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Elements in the Sun

By Charlotte E. Moore
Princeton University Observatory

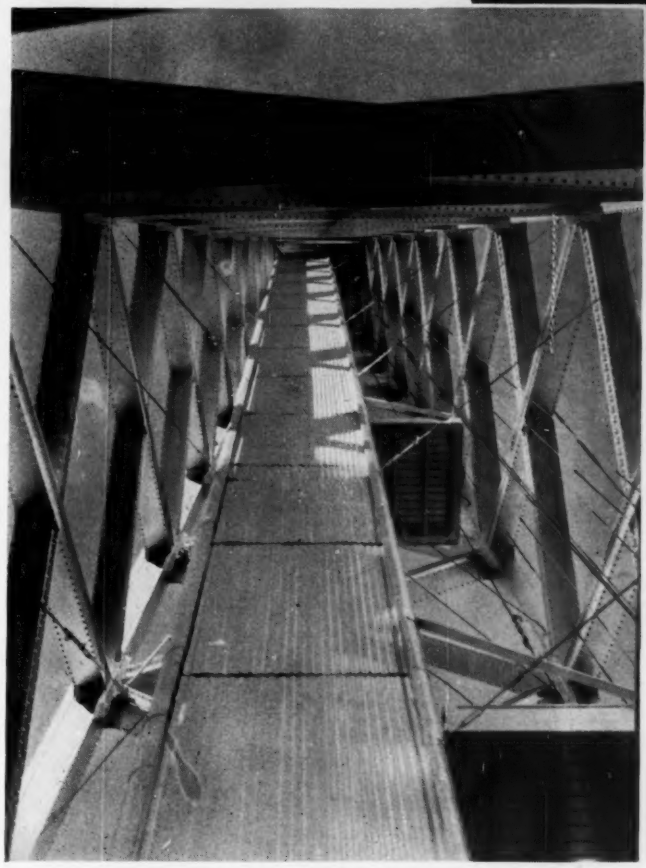
PHYSICISTS and astronomers alike have long been interested in the identification of chemical elements in the sun. As early as 1897, H. A. Rowland completed a classical piece of work—he published[1] accurate positions and estimated intensities of some 20,000 lines observed on excellent photographs of the solar spectrum, between the wave lengths 2975 and 7330. He identified 39 elements, all but two of which have been confirmed by later observations.

The solar spectrum is composite, that is, it contains lines of many elements. The oldest and most obvious method of determining the origin of solar lines is that of *coincidence:* photographing the spectrum of an element and comparing it directly with a photograph of the solar spectrum. Each element has its own characteristic set or array of spectral lines. In the ideal case, every laboratory line in the spectrum of a given element can be accurately matched in the solar spectrum, both in position and intensity. The spectrum of iron is almost ideal in this respect. Other elements, such as hydrogen, calcium, magnesium, silicon, and sodium, can be identified without question. All of the leading lines of titanium and vanadium are present. Only the stronger lines of copper and zinc occur; while for silver the two strongest lines are faint in the sun and the others are absent. The noticeable differences in the behavior of various elements as regards intensity and number of lines in the sun suggest that they are not equally abundant in the solar atmosphere.

As more is learned about laboratory spectra, the interpretation of the solar spectrum becomes easier. This is particularly true in the light of recent progress in spectrum analysis. An atom of a given element has a known number of outer or valence electrons. These electrons, as a result of energy absorbed by the atom either by collisions with other atoms or by electromagnetic radiation, attain certain *energy levels.* When this condition occurs, the atom is said to be *excited,* but in case the absorption is of relatively large amounts of energy, one or more of the electrons may be completely separated from the rest of the atom, which then is *ionized.*

When excited by radiation, the atoms of a gas absorb certain wave lengths corresponding to transitions of their valence electrons from their original energy levels to higher levels. Each transition, then, absorbs some light from a definite place and, there being a sufficient number of atoms in which this same transition occurs, an absorption line is seen in the spectrum. This is the basic process by which gases in the sun's atmosphere produce dark lines in the continuous spectrum of the solar photosphere.

An excited atom may return to its original state of lower energy by radiating energy or by other means. If energy is radiated, its wave length will depend upon the difference in energy represented by the falling of an electron from a higher energy level to a lower one. The many possible transitions of a large number of atoms produce light which the spectroscope breaks up into a bright-line or emission spectrum, composed of a definite array of bright lines.

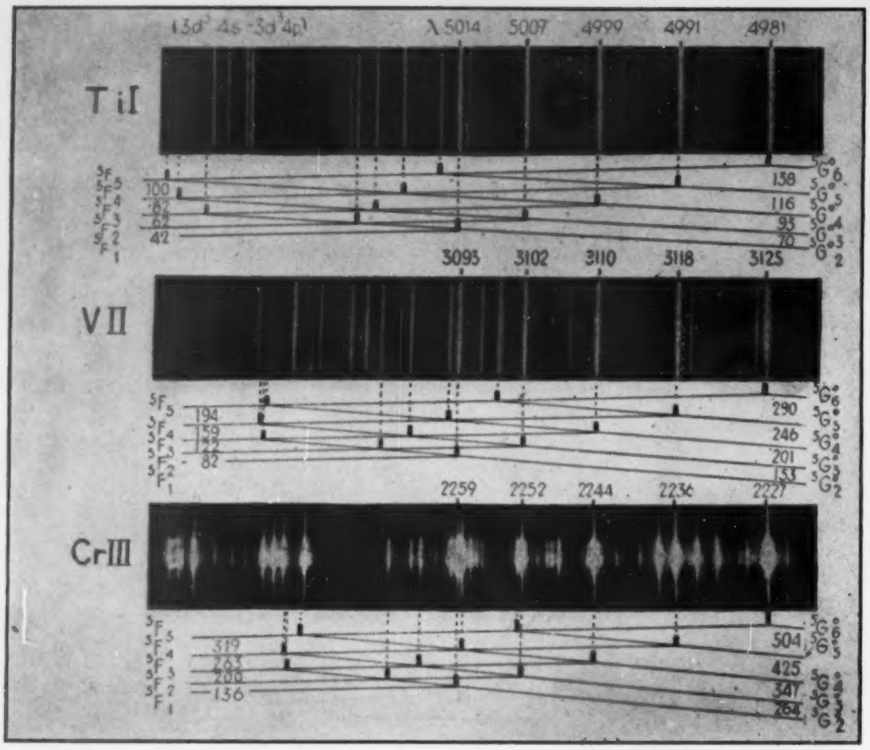


Above: The 150-foot solar tower at Mount Wilson Observatory contains a coelostat which directs sunlight downward to spectrographs and other instruments.

Left: Charles H. Coles, photographer, pointed his camera up the inside of the tower. The corrugated square tube is the telescope itself, and beside it runs the elevator, seen halfway up.

In the laboratory, atoms may be excited by placing them in an electric arc, or, for even greater energy changes, in a spark. These atoms radiate the energy they have thus absorbed, and the light of the arc or of the spark has a definite spectral pattern. From differences in the wave numbers of the observed lines, energy levels can be worked out, each line being produced by a transition between two such levels. Related levels are grouped into spectroscopic *terms* according to well-known rules. Transitions between terms give rise to groups of related lines called *multiplets.* The terms combine in such a way that a limited number of terms accounts for many spectral lines. Analyzing the spectrum consists in working out the levels, terms, multiplets, and configurations from the observed lines.

A study of the multiplets in the spectrum of a given element is important in making a search for that element in the sun. Each multiplet should be considered as a whole; that is, within any given multiplet the relative intensities in sun and laboratory should be consistent. Furthermore, the strong-



Photographs of quintet multiplets, together with the schematic representation of the electron transitions producing them. In each case the lines composing the quintet are labeled by wave lengths. From "Introduction to Atomic Spectra," by H. E. White, McGraw-Hill.

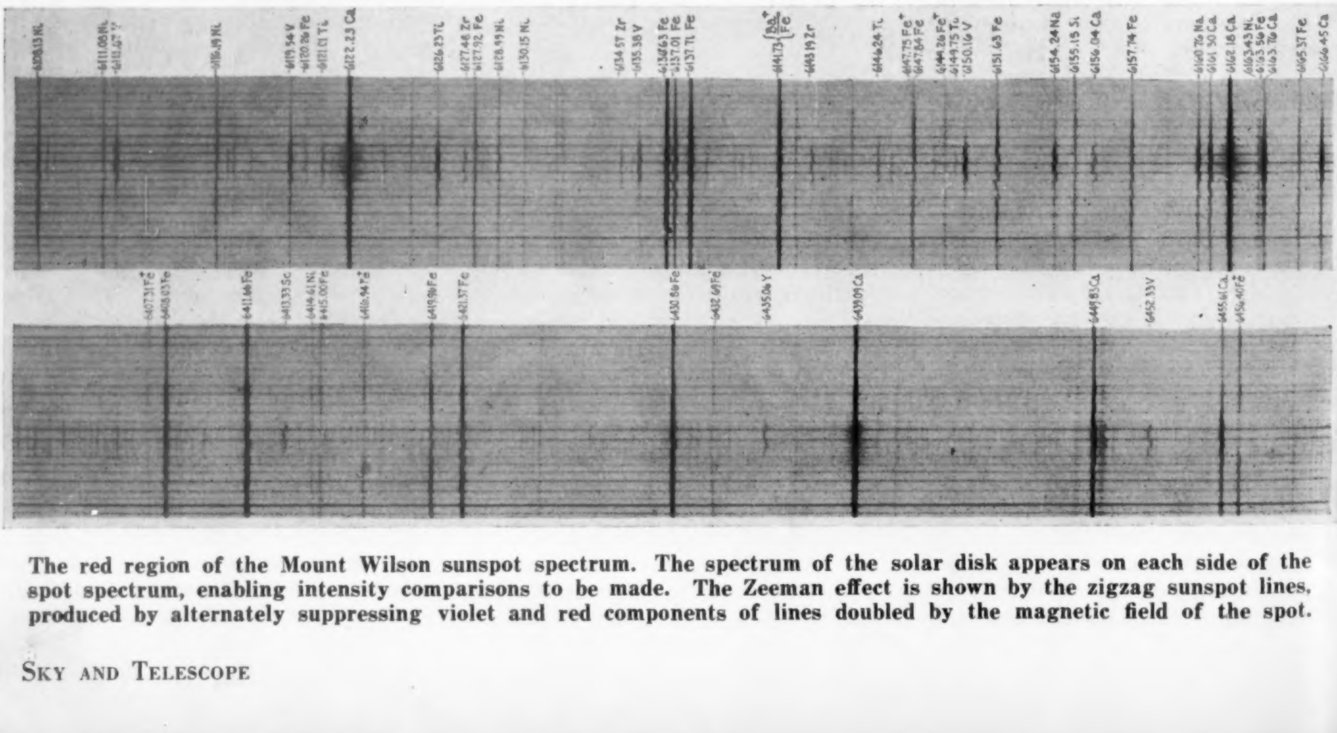
est lines in the multiplets, produced by the lowest terms, should be present in the solar spectrum if the element is represented there. These lines, arising from the lowest levels in the atom, are known as the *ultimate* lines—they are the easiest to produce in the laboratory and are the ones most likely to appear in the sun. Erroneous solar identifications may result from chance coincidence of laboratory and solar wave lengths, unless the ultimate lines of an element and the behavior of the intensities of the lines in the multiplets are considered.

Further complications are introduced by the limitations of the solar material. The ozone in our atmosphere masks the violet region of the solar spectrum, so that our observations lie only to the red of wave length 2975. Many elements have their ultimate lines to the violet of this limit, so the search for these elements in the sun must be made among lines from higher energy levels. Here again the intensities within the multiplets are a valuable guide, and unless the strongest lines of a multiplet are present or accounted for in the sun, chance coincidence of the weaker members with solar lines is insignificant.

In dealing with solar identifications, one must always consider the possibility of masked and blended lines. In many cases, lines of one element completely mask those of another. Similarly, two lines of a given element or lines of several elements may contribute to the production of one solar line. The relative intensities of the various contributors and the differences in solar and laboratory wave lengths are of great assistance in deciphering these complicated cases.

Fortunately, our study of elements in the sun is not restricted to the solar spectrum, which is produced by light from the solar disk. Spectra of sunspots and of the chromosphere are also available. The three kinds of spectra are produced under different physical conditions, and consequently a comparison of the behavior of lines in the three sources, in the light of our present knowledge of the origin of spectra, yields valuable information. The sunspots are cooler than the disk, and the temperature differences are reflected in the spectra produced in the two sources. Similar differences are observed in laboratory spectra taken at low and high temperatures. The low-level lines of an atom are relatively stronger in the low-temperature source than at high temperature. Accordingly, these lines are stronger in the spot spectrum than in that of the disk. Conversely, high-level arc lines, and spark lines (which are produced by an atom that has been ionized) are weakened in the spot spectrum. The spot spectrum thus provides a valuable check on the correctness of solar identifications.

Because of the temperature difference between disk and spot, one element, indium, is found only in the spot spectrum, and the ultimate lines of lithium and rubidium were first found in sunspots, although they appear very faintly in the disk spectrum. The ultimate line of thallium agrees in wave length with a faint solar line, but this must be an

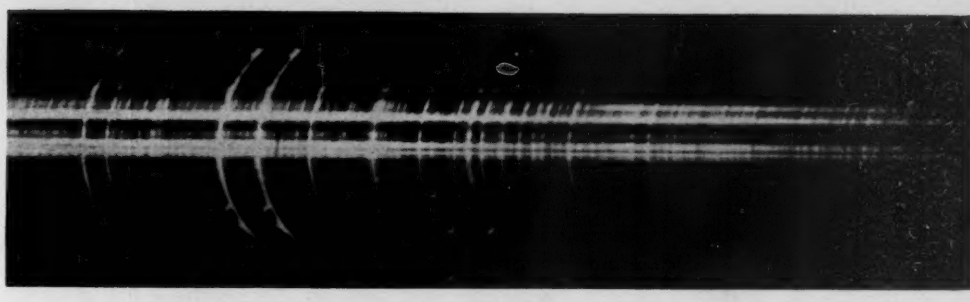


The red region of the Mount Wilson sunspot spectrum. The spectrum of the solar disk appears on each side of the spot spectrum, enabling intensity comparisons to be made. The Zeeman effect is shown by the zigzag sunspot lines, produced by alternately suppressing violet and red components of lines doubled by the magnetic field of the spot.

accidental coincidence, since the line is not strengthened in the spot spectrum. On this evidence, thallium is one of the two elements erroneously listed by Rowland as present in the sun.

The behavior of compounds in solar and spot spectra may be mentioned. The higher temperature in the disk dissociates most molecules. For example, lines of titanium oxide and calcium hydride are present only in the spot spectrum.

The intensity behavior of lines in the disk and spot spectra is illustrated in the photo on the facing page. The spot spectrum appears in the middle of each strip and that of the disk is at the top and bottom. The strengthening of the lines of calcium, titanium, vanadium, yttrium, and zirconium in the spot is conspicuous; while lines due to the first spark spectrum of iron (marked Fe+) are weakened or obliterated in the spot spectrum.



The spectrum of the solar chromosphere in the violet and ultraviolet. This is a flash spectrum, taken just before the beginning of totality at a solar eclipse. The length of each arc indicates how high above the sun the element producing it extends. The two strongest lines are due to ionized calcium.

Two regions observed by Babcock. The upper one illustrates the effect of an atmospheric band; it almost completely masks the solar spectrum. The lower one, near wave length 10000, shows a clear solar region where strong lines due to silicon and carbon predominate.

A study of the solar chromosphere can be made from the flash spectrum, which is usually observed at the time of a total eclipse of the sun. This spectrum is produced at a higher level in the solar atmosphere than that of the disk, and conditions are favorable for the appearance of spark lines. The most conspicuous lines are, however, due to hydrogen and helium. In fact, helium was first discovered in the flash spectrum, at the total eclipse of 1868, but it was not isolated in the laboratory until years later.[2]

Much progress has been made in the identification of solar lines, but the work is still incomplete. In 1928, a revision of Rowland's "Preliminary Table of Solar Spectrum Wave-Lengths" was made at Mount Wilson by Charles E. St. John and others.[3] At that time, 57 elements were listed as present in the sun.

It has long been realized that observations of the solar spectrum should be extended to the infrared. In 1919, William F. Meggers reached wave length 9000.[4] The rapid development of red-sensitive plates has made it possible to carry the work further, and a notable piece of research has been done at Mount Wilson by H. D. Babcock. He has photographed the solar spectrum to wave length 13500, and added more than 4,700 lines to Rowland's original list. The preparation of a publication on the infrared solar spectrum, containing his results, is now in progress. This will also cover the overlapping region from wave lengths 6600 to 7330, where Rowland's plates began to lose their sensitivity and where several hundred additional lines have been observed.

Heavy bands produced by the oxygen and water-vapor molecules in our own atmosphere mask the solar spectrum in sections of the red and infrared. In regions where a clear solar spectrum can be observed, however, important atomic lines have been identified. Some of the strongest are due to carbon, sulphur, oxygen, and silicon.

The accuracy of Babcock's measures far surpasses that of laboratory measures in the red. This led to the discovery of the presence of two series of magnesium lines, which were heretofore very incompletely observed.[5] Phosphorus was also detected in the region covered by Babcock.[6] In general, lines of the non-metals appear in the red, which explains why Rowland did not find them.

A wealth of laboratory and solar material is now available for work on the identification of solar lines. With the aid of all the known multiplets of arc and spark spectra, the writer is at present engaged in an extensive study of these identifications, from the violet to the infrared. One piece of spectrum analysis, namely, that of the arc spectrum of iron, which is now in process of publication, has made possible the identification of several hundred faint solar lines which have heretofore been unidentified. From the well-known term values of iron, accurate wave lengths of "predicted" lines can be calculated. The high abundance of iron in the sun favors the appearance of faint iron lines and many of the predicted lines are found there, although they have not yet been observed in the laboratory.

Other work on laboratory spectra has been equally useful, and hundreds of important references might be listed. It is hoped that in the none too distant future the solar identifications may become somewhat definitive, although much still remains to be done.

To date, a total of 66 of the 92 elements in the periodic table have been found in the sun, of which four are somewhat dubiously identified. These four are in parentheses in the accompanying list. Two elements, boron and fluorine, are detected in the sun only in compounds.

The elements most recently discovered are thorium[7] and gold.[8] Thorium is of special interest because it is the only radioactive element known to be present

ELEMENTS IN THE SUN

Hydrogen	H	Columbium	Cb
Helium	He	Molybdenum	Mo
Lithium	Li	Ruthenium	Ru
Beryllium	Be	Rhodium	Rh
Boron	B	Palladium	Pd
Carbon	C	Silver	Ag
Nitrogen	N	Cadmium	Cd
Oxygen	O	Indium	In
Fluorine	F	(Tin	Sn)
Sodium	Na	Antimony	Sb
Magnesium	Mg	Barium	Ba
Aluminum	Al	Lanthanum	La
Silicon	Si	Cerium	Ce
Phosphorus	P	Praseodymium	Pr
Sulphur	S	Neodymium	Nd
Potassium	K	Samarium	Sm
Calcium	Ca	Europium	Eu
Scandium	Sc	Gadolinium	Gd
Titanium	Ti	(Terbium	Tb)
Vanadium	V	Dysprosium	Dy
Chromium	Cr	Erbium	Er
Manganese	Mn	Thulium	Tm
Iron	Fe	Ytterbium	Yb
Cobalt	Co	Lutecium	Lu
Nickel	Ni	Hafnium	Hf
Copper	Cu	(Tantalum	Ta)
Zinc	Zn	Tungsten	W
Gallium	Ga	Osmium	Os
Germanium	Ge	Iridium	Ir
Rubidium	Rb	Platinum	Pt
Strontium	Sr	(Gold	Au)
Yttrium	Y	Lead	Pb
Zirconium	Zr	Thorium	Th

in the sun. The detection of gold has resulted from recent work on the laboratory analysis of this spectrum, which revealed a strong accessible line from a moderately low energy level. It coincides with a faint solar line, strengthened in sunspots.

The 26 elements not found in the sun are distributed as follows: For six, the laboratory data are still inadequate; four have ultimate lines accessible, and, if present, are too rare to be detected spectroscopically; 11 have ultimate lines inaccessible, and the observable lines would not appear unless the abundance of the elements were high; the five remaining are radioactive elements of relatively short life.

The general subject of the correct identification of solar lines is of far-reaching astrophysical significance. For example, the enormous abundance of hydrogen, as judged from the conspicuous strength of its lines in the sun, has an important bearing on the study of stellar constitution.

From a study of intensities of unblended solar lines of various elements, H. N. Russell has calculated the abundance of 56 elements in the sun's atmosphere.[9] These results could now be revised for some elements, but in general as more becomes known, the agreement in composition of earth, sun, and meteorites becomes better and better (with the exception that hydrogen and helium are much more abundant in the sun).

Improved spectrograms near the violet limit of the solar spectrum can now be made, and identifications in this region can be greatly extended in the near future.

The *Photometric Atlas of the Solar Spectrum,* recently prepared by Minnaert, Mulders, and Houtgast,[10] provides a wealth of material for future study. Many other fields of investigation might be mentioned, but it is hoped that the present brief survey will suffice to show that the subject not only is very important, but is in itself tremendously interesting.

[1] **Astrophysical Journal, 1-5**, 1895-97.

[2] Russell, Dugan and Stewart, **Astronomy, 2**, 504, 1938, Ginn and Company, N. Y.

[3] Carnegie Institution of Washington, **Publication** No. 396; Papers of the Mount Wilson Observatory, III, 1928.

[4] **Publications** of the Allegheny Observatory, **6**, 13 (No. 3), 1929.

[5] Russell, Babcock and Moore, **Physical Review, 46**, 826 (No. 9), 1934.

[6] Moore, Babcock and Kiess, **Astrophysical Journal, 80**, 59, 1934.

[7] **Publications** of the Astronomical Society of the Pacific, **55**, 36 (No. 322), 1943.

[8] **Ibid, 55**, 109 (No. 323), 1943.

[9] Mount Wilson **Contribution** No. 383; **Astrophysical Journal, 70**, 56, 1929.

[10] D. Schnabel; Kampert and Helm, Amsterdam, 1940.

In Focus

"ON THIS strip of territory [the southwest extremity of Portugal, now known as Cape St. Vincent] were to dwell a community that would, so to speak, dictate the maritime policy of the world. Here was to be the finest naval college which ever existed even to this day. Here were brought together the pick of the world's seamen and navigators of that time. From here were to issue both great explorers and the influence which caused all those other navigators to open up the world as a man opens a closed book. To this day civilisation has not realised one tithe of what it and the seafaring nations especially owe in respect of shipbuilding, navigation, and overseas commerce to that small stretch situated at the end of the Spanish peninsula. The success which followed was the result of a wonderful personality. It was the triumph of a man who possessed in one combination the gifts of a far-seeing imagination, a scholarly mind, and a genius for organisation allied to a passion for the sea and the finding of new lands."

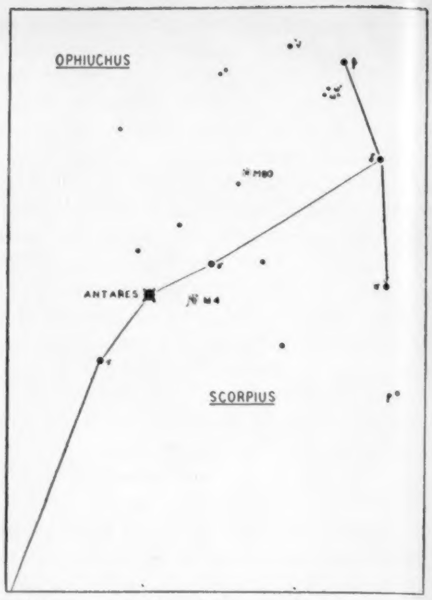
This tribute to Prince Henry of Portugal (1394-1460), pictured on our front cover this month (after a print by Simon de Passe), is made by E. Keble Chatterton, in his book, *Ships and Ways of Other Days* (J. B. Lippincott Company, 1913). Largely through the efforts of Henry, the Navigator, the art of navigation was greatly furthered at the naval college at Sagres, of which Mr. Chatterton speaks, and the learning accumulated there was directly responsible for the great period of exploration of the late 15th and early 16th centuries.

Prime object, of course, of this exploration was to reach India, but Henry is also credited with the desire to find the true shape of the earth. At Sagres, data from voyages of all sorts were tabulated; maps and instruments were constantly improved; astronomical and mathematical knowledge from the entire known world was studied and correlated. Mr. Chatterton says further:

"If only people understood half they owed to this man they would commemorate his name in every important seaport of the world."

ON THE back cover this month is reproduced part of the Milky Way in the region of Scorpius and Ophiuchus, from the Ross-Calvert *Atlas of the Northern Milky Way*. Details of the exposure time and instrument used will be found on page 2.

Reference to the accompanying small-scale diagram will help in identifying some of the interesting objects in the field. The three bright stars in the head of the Scorpion are in the upper right part of the picture. On the cover, one degree is represented by slightly less than one inch. The 1950 co-ordinates of Antares are $16^h\ 26^m\ 20^s$, $-26°\ 19'.4$.



Of special interest are the dark lanes running from the nebulosity above Antares into Ophiuchus in the upper left portion of the picture. The brightest and largest nebulosity surrounds the star Rho Ophiuchi, so that in most reproductions of the region, one will find this star mentioned in the caption. Dr. Bart J. Bok states that the dark nebulosity here "is probably part of the giant dark nebula in Ophiuchus, which according to the evidence from the distribution of stars and faint galaxies covers an area of one thousand square degrees. The great body of the nebular mass lies from five to twenty degrees north of the galactic circle and lacks the background of faint stars to render it conspicuous. The low latitude 'tentacles' of the Ophiuchus nebula, however, are seen projected against some of the richest portions of the Milky Way and the nebula near Rho Ophiuchi is one of these tentacles."

Note the large globular cluster, M4, to the right of Antares, and compare it with the compact globular, M80. Antares itself is comparatively faint, because it is a red star, while the nebulosity involving Sigma Scorpii (to the right and above Antares), a 3rd-magnitude blue-white star of spectral class *B1*, makes it very conspicuous. Tau Scorpii is almost exactly like Sigma both in magnitude and spectral class (color), but is evidently not enshrouded in nebulosity.

The reproductions in the atlas itself were made by contact printing from second negatives.

On the original negatives, the limiting magnitude for most of the plates is 17.0, with a loss in the paper prints of 0.5 magnitude. Further loss is caused by vignetting at the corners of the plate.

Saluting an Astronomer

By Joseph R. Habes, S.J., *West Baden College*

All of us are acquainted with the remarkable discoveries and calculations of the early Greek astronomers and mathematicians. We cannot forget Thales of Miletus, whose claim to a place in the history of astronomy rests almost entirely on one achievement attributed to him, that of predicting an eclipse of the sun which took place during a battle between the Lydians and the Medes in the year 585 B.C. Anaximander, as we remember, was aware of the obliquity of the ecliptic, while Empedocles proposed the theory that light travels and takes time to pass from one point to another. Then, too, there are Aristarchus of Samos, who anticipated Copernicus in the promulgation of the heliocentric system, and Hipparchus, who discovered the precession of the equinoxes.

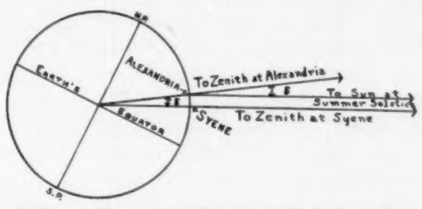
Yet another Greek scientist, Eratosthenes by name, deserves our special attention when we look up at the galaxy of our ancient forefathers whose names are written eternally in the hall of fame.

Eratosthenes of Cyrene (276?-195? B.C.) was an eminent astronomer and geometer. After considerable training at the flourishing cities of Alexandria and Athens, he was installed by Ptolemy III Euergetes in the office of librarian at Alexandria. There he developed a taste for almost every branch of learning, and consequently, his writings cover an enormous range. Besides innumerable other works, he wrote a commentary on Plato's *Timaeus,* set forth his astronomical views in the poems, *Hermes, Erigone,* and *Anterinys,* summarized the mythology of astronomy in his work, *Katastherismoi,* and compiled the *Geography,* his greatest scientific publication.

But Eratosthenes probably gained an immortal reputation by his scientific measurement of the earth. Early physicists and natural philosophers held different views regarding the size of the earth, but the view of Eratosthenes they preferred to all the rest.

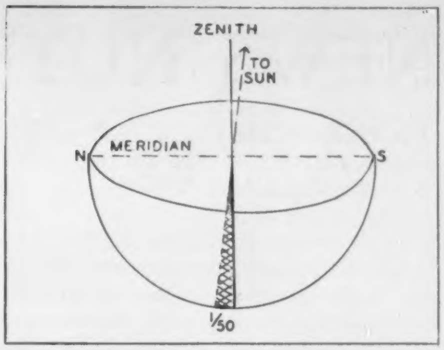
The method of this Greek astronomer, handed down to us by Cleomedes in his book, *De Motu Circulari Corporum Caelestium,* depends on a geometrical argument. It will be difficult to follow his successive inferences unless we are aided beforehand by certain appropriate data. To begin with, we must first suppose that Syene (modern Assuan), a city along the Nile River, and Alexandria lie on the same meridian circle. (As a matter of fact, Syene is located approximately three degrees east of the Alexandrian meridian.) Secondly, the distance between the two cities is 5,000 stadia (to be taken at a round figure); thirdly, because of the great distance from the sun to the earth, astronomers generally consider the rays of the sun as parallel by the time they reach the earth. In the fourth place, we know from Euclidean geometry two accepted theorems, namely, that straight lines cutting parallel lines make alternate angles equal, and that the arcs subtended by equal angles are equal.

Anyone, according to the account of Cleomedes, who has grasped these essential facts should have no difficulty in understanding the method of Eratosthenes. Syene and Alexandria lie nearly on the same meridian circle, which is a great circle of the earth. Now Eratosthenes asserts that at noon at the summer solstice, the sun throws no shadow at Syene, as it is directly overhead. At the same hour at Alexandria, the pointers of the sundials throw shadows, because Alexandria is farther north than Syene. The arc of the shadow will represent a segment of a great circle in the hemispherical bowl of the sundial, since the bowl lies under the great circle.



This diagram illustrates how the sun appears in the zenith at Syene at the same time it is about seven degrees south of the zenith at Alexandria.

If, as shown in the diagram, we draw from the sun two straight lines, one through the pointer at Syene, another to the extremity of the shadow through the pointer at Alexandria, we have parallel lines, since straight lines coming from the sun are parallel. Upon this recognized assumption, if a line is drawn from the center of the earth to the pointer at Alexandria, it will make alternate angles equal. Since the angles are equal, they subtend equal arcs. But as Eratosthenes discovered the arc in the bowl of the dial to be 1/50 of its circle, the arc of the earth which is the reckoned distance between Syene and Alexandria, 5,000 stadia, must be 1/50 of the great circle of the earth. By this simple geometrical proof, Eratosthenes arrived at 50 times 5,000, or 250,000 stadia, as the circumference of the earth.



In the bowl of the sundial, Eratosthenes observed the noontime shadow at Alexandria to occupy 1/50 of a circle.

This is the figure given by Cleomedes; but Strabo maintains that Eratosthenes measured the earth as 252,000 stadia in circumference. Because of the circumstantial account of Cleomedes, we can hardly believe that 252,000 stadia was the original measurement of Eratosthenes, but that he changed it later to 252,000 for some unknown reason.

A real discrepancy arises, however, when we consider the length of the stadium used by the Greek astronomer. The Greek dictionary gives 606.75 feet to a Grecian stadium. Yet this standard, with reference to this case, is not acknowledged as accurate by modern research scientists in the history of ancient astronomy. They generally prefer to accept the statement of Pliny in his *Naturalis Historia,* where he claims that Eratosthenes made 40 stadia equal to the Egyptian *schoinus.* If this be so, and taking the *schoinus* at 12,000 royal cubits of 0.525 meters, we obtain 300 such cubits or 157.5 meters as the length of the stadium, which is equal to 516.73 of our feet. The circumference of the earth, being 252,000 times this length, is therefore about 24,662 miles, and the diameter of the earth, on this basis, is about 7,850 miles. This figure is only 50 miles short of the true polar diameter! Indeed, this computation is a surprisingly close approximation to reality, and is considered to be one of the first great triumphs of scientific calculation.

I SAW A STAR*

I saw a star, a single star
A shining light against the blue.
It gave me hope, it gave me strength
And courage that I never knew.

I saw a star, a single star
When all at once I saw the way,
And so I closed my eyes and slept
And then began another day.

ELEANOR FRANCES DELAPLAINE

*On a bronze tablet at the entrance to a garden at Hood College, Frederick, Md., are these lines written by a girl of 15 years. The garden, an outdoor reading room for the new Joseph Henry Apple Library, was given in memory of the child, who lived near the campus and died before she was quite 16. The library was built in honor of the president emeritus of the college, who was the first teacher of astronomy there. LEAH B. ALLEN

NEWS NOTES

By Dorrit Hoffleit

FRANK SCHLESINGER AND TRIGONOMETRIC PARALLAXES

With the death on July 10th of Dr. Frank Schlesinger, director emeritus of the Yale University Observatory, we have lost one of the great astronomers in the field of astrometry. To Dr. Schlesinger, more than to anyone else, goes credit for the tremendous growth in the knowledge of the trigonometric distances of the stars within the 20th century.

Over 100 years ago, Bessel, Henderson, and Struve, after laborious efforts by astronomers through centuries, finally succeeded in finding the distances for a few stars. Although their methods proved sound, progress was extremely slow, and, until the advent of celestial photography, but 30-odd trustworthy distances had been determined.

The first photographic attempts at parallax measurement came in the 1880's, and numerous researches on the subject were published up to the end of the century. The problem was, however, still in the experimental stage.

When the Yerkes 40-inch refractor was installed, Dr. Schlesinger soon realized the advantages so large and excellent an instrument might offer, and he consequently undertook a parallax program. His papers in the *Astrophysical Journal,* in the early years of this century, on the methods to be employed, the sources of errors that may be encountered, and how to minimize their effects, are classical standards.

From Yerkes, Dr. Schlesinger went to Allegheny, as director. Allegheny has ever since maintained a lead in the total number of parallaxes determined at any observatory (though of late McCormick is a close second). Thence he was called to Yale, where he was director of the observatory for 21 years. There he was instrumental in the building of the 26-inch refractor used at Johannesburg, South Africa, in finding the distances of southern stars. (See "Forty Years of Photographic Astrometry," The SKY, February, 1941.)

Dr. Schlesinger is the author of over 200 papers and catalogues. Probably the most thumbed of these are the *Bright Star Catalogue* and *General Catalogue of Parallaxes,* indispensable sources of information on individual comparatively nearby stars. Your reporter believes one small paper stands out like a diamond among the other jewels. It is an excellent summary in the Seeliger *Festschrift* (1924) on the methods and precautions to be followed in trigonometric parallax investigations. I know of no other paper in astronomical literature that contains in so few pages so concise and yet so complete an account of this photographic problem. Many small refinements have come since Dr. Schlesinger began his work; but practically all the problems encountered thus far had already been at least mentioned by him in this excellent little treatise.

When Frank Schlesinger began his investigations, scarcely 100 parallaxes (or distances) were known to a fair degree of accuracy. Now, mainly as a consequence of his standardization of the methods, the number has grown to a few thousand.

CONTRIBUTIONS ON METEORITES

Volume 3, No. 1, of the *Contributions* of the Society for Research on Meteorites has recently been distributed. These contributions are collected from the regular issues in *Popular Astronomy* for 1942. The 64-page pamphlet contains an impressive assortment of papers covering, among other things: meteorite detectors, discussions of comets that struck the earth, the distribution and origin of lunar craters, the compressive strength of meteorites, nitrogen and its compounds in meteorites, and the Pultusk meteoritic shower.

EINSTEIN IN WAR WORK

Science reports that Albert Einstein, of relativity fame, has joined the United States Navy Ordnance Bureau as a "staff member extraordinary," for research work on the phenomena governing explosives.

COMET OTERMA 1943a

Comet Oterma 1943a, discovered by the Finnish woman astronomer in April, is not just a commonplace comet. While some orbit students may have had a little difficulty determining just what sort of a path it follows, L. E. Cunningham and R. N. Thomas have been successful in finding out. We generally think of comets as moving in pronouncedly elongated ellipses. This one's orbit is very round. Astronomers express the shape of an orbit by the term *eccentricity*; the eccentricity of a circle is zero. Mercury's and Pluto's orbits —the most eccentric among the planets —have eccentricities of 0.2; while Comet Oterma 1943a has an eccentricity of only 0.14.

The investigators report: "The elements indicate that this comet is the second one so far discovered which can easily be observed throughout its orbit." The other such comet is Schwassmann-Wachmann 1925II, the one that has been so often mistaken for a *new* comet because of its erratic changes in brightness. (We commented on this in November last year, and the Indian publication, *Science and Culture,* discusses it in its March, 1943, number, just received—the comet having recently again been re-mistaken for a new one!)

Comet Oterma 1943a takes about eight years to go around the sun. At its last aphelion passage in 1938, it passed within half an astronomical unit of Jupiter. This massive planet exerts an impressive attraction on small things passing so close, greedily trying to capture them. Cunningham and Thomas state, "Thus it appears probable that the present orbit is very much different from the one which it had previous to that encounter." Probably after the war, some astro-detective will be looking into this comet's past aliases.

E. C. SLIPHER HONORED

An honorary doctorate of science has been conferred on E. C. Slipher by the University of Arizona. Dr. Slipher, an astronomer on the staff of Lowell Observatory, where Percival Lowell made his famous studies of Mars, is an authority on planetary atmospheres.

ACCURACY OF MODERN NAVIGATION TABLES

By means of the punched card system and tabulating machines, Dr. Charles H. Smiley, of Brown University, has conducted an investigation of the accuracy of the figures given in modern navigation tables, such as those of Dreisonstok (H.O. 208), Ageton (*Manual of Celestial Navigation*), and Comrie's *Hughes' Tables.* His results show that for the first of these, there is an estimated total of about 3,000 errors (2,892 recorded to June 10th), but only seven per cent are of two units or more in the last decimal place. The largest errors are on the order of 20 units in the last place, and are found mostly in the cases of high declination. In practice, this means that for a star of high declination near the observer's zenith, there might be a resultant error of about 4.4 nautical miles in a position computed using the tables, but this is, of course, the extreme case.

In comparing other tables with Dreisonstok, Dr. Smiley found evidence of hereditary influence, many errors being common to two publications. He warns, too, against the practice followed by some computers of using these navigation tables for purposes other than those for which they are intended.

Dr. Smiley's complete paper on this subject appears in the July issue of *Mathematical Tables and Aids to Computation,* published by the National Research Council.

Nautical Notes

By William H. Barton, Jr.

Sailing the Seven Seas is the title of the demonstration at the Hayden Planetarium this month. Here the curator tells some of the interesting sidelights which show that navigation as we have it today is the result of many centuries of slow development.

In our enthusiasm to learn and practice the art of navigation, as it is developed today, we sometimes overlook the interesting little details from the past that throw light on the subject.

Navigation on the sea runs back so far that its beginning is lost in antiquity. Perhaps Jason was the most ancient of navigators. You may recall that he was the leader of the Argonauts who sailed in search of the Golden Fleece. Jason, upon his return, is said to have settled down in Corinth with his wife Medea. His death, according to one version, was occasioned by the stern of his good ship *Argo* falling upon him and crushing him.

Jason's ship can be found in the sky, situated south and east of Canis Major. The name Argo, however, is no longer official. The constellation has been broken into four groups: Carina (Keel), Pyxis (Mariner's Compass), Vela (Sails), and Puppis (Stern). So the very part that is said to have caused Jason's death is commemorated in the stars. There are navigation instruments represented elsewhere in the sky, too. At the south celestial pole is Octans, the Octant, while under Leo is Sextans. There are Horologium, the Clock (chronometer), and Circinus, the Compasses, which, by a slight poetic license, may be considered dividers used in navigation.

The navigational star chart in the *American Nautical Almanac* still shows Argo as one constellation, with four of its stars in the basic list of 55 navigational stars. These are Canopus (Alpha Carinae), Al Suhail (Lambda Velorum), Miaplacidus (Beta Carinae), and Epsilon Carinae. The additional list gives 10 more stars in Argo as of use to navigators. Even though Argo is no longer sanctioned by astronomers, the original order of Greek and Roman letter designations has been maintained, so that Vela, Puppis, and Pyxis have neither Alpha nor Beta, while Carina has no Lambda nor any of the designations applying to stars in any of the other three groups. Gamma and Delta are in Vela, and so it goes.

To most navigators, then, the ship in the sky is still Argo, or Argo Navis. The word navigation comes from *navis,* meaning ship.

Among the western nations, before the use of the magnetic compass, the only practical means of navigation was to keep in sight of the shore, or occasionally for short distances to use the sun or stars for guiding the ship on its course. But cloudy weather made this difficult and dangerous, so that even on short voyages on the Mediterranean, the navigator would become hopelessly lost.

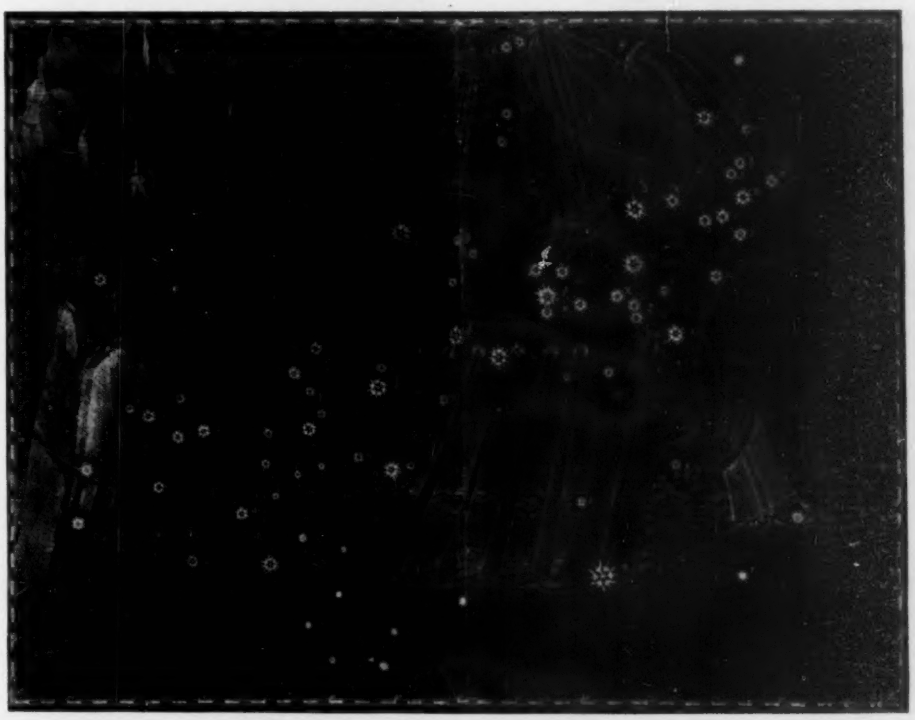
Over the China Sea and the Indian Ocean, the steadiness in direction of the monsoons was observed very early, and by running directly before the wind, vessels went long distances out of sight of land.

Up to the time of the Portuguese exploring expeditions, sent out by Prince Henry, known as The Navigator, navigation was conducted in the most crude, uncertain, and dangerous manner. Prince Henry's expeditions discovered the Azores in 1419, rediscovered the Cape Verde Islands in 1447 and Sierra Leone in 1460. The only improvement that had been made in navigation for many years had been the introduction of the magnetic compass in the 14th century. Prince Henry encouraged the development of the art by establishing an astronomical observatory near Cape St. Vincent. The chief function of this was to improve the tables for the declination of the sun, to aid in the determination of latitude.

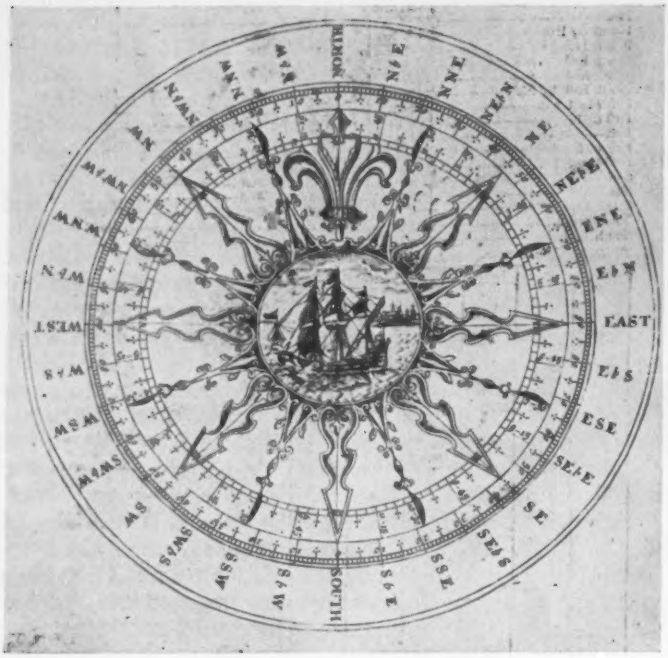
John II, who took the throne in 1481, continued this patronage of astronomy and navigation. The course of instruction prescribed for pilots at this period included Sacrobosco's *De Sphaera Mundi,* Regiomontanus' spherical triangles, Ptolemy's *Almagest,* the mechanism and use of the astrolabe, adjustments of instruments, cartography, and the methods of observing the heavenly bodies.

The mystery of finding longitude was not solved for many years. Even the most optimistic could hope only to find the latitude. A writer of a nautical book of the day gives this sage advice: "Now there be some that are very inquisitive to have a way to get the longitude, but that is too tedious for seamen, since it requireth the deep knowledge of astronomy, wherefore I would not have any man think that the longitude is to be found at sea by any instrument; so let no seamen trouble themselves with any such rule, but (according to their accustomed manner) let them keep a perfect account and reckoning of the way of their ship." The record of the "way of the ship" appears to have been then and for many years later recorded in chalk on a wooden board (log board) which folded like a book, and from which each day a position for the ship was deduced. Hence, the *log* and *dead* (ded. or deduced) *reckoning.*

It is the impossibility of following



Bayer, in his "Uranometria," from which this reproduction is made, shows only the stern portions of Argo Navis. Canopus is in the lower right, level with the water, in what is now called the keel of the ship. The four stars which form the False Cross are in the oars, to the left of and slightly below center, but not near the sail, in which two of them are now placed. Puppis, however, does represent the stern.



This "Figure of the Sea-Compass" is from a book by Capt. Daniel New-House, "The Whole Art of Navigation," published in 1701. "The chief Use of the Sea-Compass is to show us at any time . . . the North, South, East, West, and all other Points . . . . Therefore, the first thing you are to learn, is to name by Heart all the Points of the Compass in order, and to know them as soon as you cast your Eye on your Compass." Note the scale showing degrees.

this ancient advice to keep a "perfect account" that makes celestial navigation necessary.

As early as 1514, John Werner of Nuremberg described the cross-staff and said that it was then just being introduced to seamen. For finding the longitude, he suggested measuring the distance between the moon and one of the many stars along the ecliptic. This was the beginning of "lunars." In Nathaniel Bowditch's book of a century ago you can find a number of methods of taking and reducing lunars. The method was always a difficult one, and in Werner's day quite impractical, since there were no satisfactory tables of the moon.

In 1537 Pedro Nunes, cosmographer to the king of Portugal, published a book on astronomy, charts, and some points of navigation. Among his many astronomical problems is one for finding the latitude by knowing the sun's declination and altitude when on two bearings not less than 40 degrees apart. R. Gemma, about 1530, had done a similar problem with two stars. So the "double altitude" problem is not exactly new. And what is more to the point, Nunes could solve the problem mechanically to within a degree by plotting on a large globe.

In a recent article in *Fortune,* a writer proposed the plotting of two star sights on a globe to get a fix, without all the bother and fuss that a navigator must go through if he employs the methods in current use by the Army and Navy. He criticized the officers in the Services for using an "old-fashioned" method (the Sumner line does date from 1837) and proposed his "new" and novel scheme. Apparently neither the author of that article nor the editor was acquainted with tried and rejected methods.

The writer of this article is frequently consulted by inventors of "new" navigation schemes who know nothing of the old ones.

Pedro de Medina published in 1545 what appears to be the first book entirely devoted to navigation. His *Arte de Navigar* was dedicated to Don Philippos, Prince of Spain. It was translated into French and Italian, and after many years, into English. This book, appearing within two years of the death of Copernicus, was based on Ptolemaic astronomy.

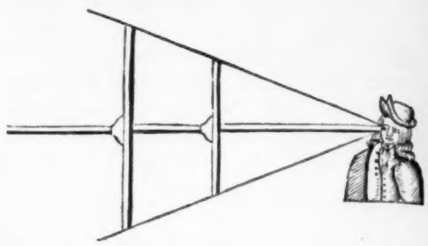
Almanacs were first published in Europe in 1457 and in England in 1497. The parts of most interest to navigators were tables of declination of the sun, positions for a few stars, and tables for finding latitude by Polaris. No accurate predictions of the positions of the moon, stars, and planets could be made. The laws governing their movements were not known at this time. Edmond Halley undertook a voyage in 1699 to improve the knowledge of longitude and magnetic variation.

That the magnetic compass did not point true north was known at a very early date, but the change in the variation at different places seems to have been studied first by Columbus or Cabot about 1490. There were two ways of determining variation at sea. One was to take a bearing on the pole star and the other to average the compass readings on the rising and setting sun. Compass makers frequently adjusted the compass card for variation by placing the supporting magnetic needles off the north point of the card by the proper amount, which is all right if you don't stray too far from home.

Deviation, that correction which is so important today, was not much bother in the early days. There were no steel ships and no electrical machinery to bother the compass. But in 1679, Captain Sturmy of Bristol noted that a cargo of iron should not be placed in the vicinity of the magnetic compass.

By the same token our Air Corps officers' uniform caps are soft crowned, not tightened by a wire as in other branches of the service. This has, by now, become a symbol or tradition. It is based, however, on the fact that the wire would be a disturbance to the compass. In a recent release from the British Information Bureau, the story is told of "swinging the ship" to check compass deviation. In the instance described, a certain amount of deviation could not be accounted for. Hours of investigation disclosed that the circle of wire used for stiffening the pilot's cap was the cause of the trouble. Sometimes it is a pocket knife or even a metal stud in the heel of a pilot's shoe which affects the compass.

The fleur-de-lis that marks the north point on a compass card appeared about the time Columbus sailed for America. Long before there were compasses, wind roses (Rosa Ventorum) appeared on sailing charts. The naming of the eight principal winds goes back to the Temple



Hold the cross-staff "so your Staff stands parallel with the Center of your Eye," says Capt. New-House, and use it to take the "Altitude of the Sun or Stars."

of Winds in Athens, built by Andronicus Cyrrhestes. On the early sailing charts of the Mediterranean pilots, these wind roses were marked with the initials of the eight winds, Tramontano, Greco, Levante, Scirocco, Ostro, Africo, Ponente, and Maestro. Instead of L (Levante) to mark the east, they sometimes used a cross. In some cases north was not marked with the T but with a broad arrow or spear, and in others by a combination of T and the spear. Out of this device grew the fleur-de-lis, which is universal now.

Dividing up these eight principal parts into 32 points is probably of Flemish origin. And now use of the old points of the compass is on the wane in favor of simple degree designations, eastward around the card from 0 to 360.

Thus navigation changes, but its fundamentals do not change, or some of them change but slowly. The whole story of navigation is not written. New chapters are being added every day. Improvements are made in the manner that one of our great composers said a song was written. He said, "All you do is recall a tune nobody ever heard and write it down."

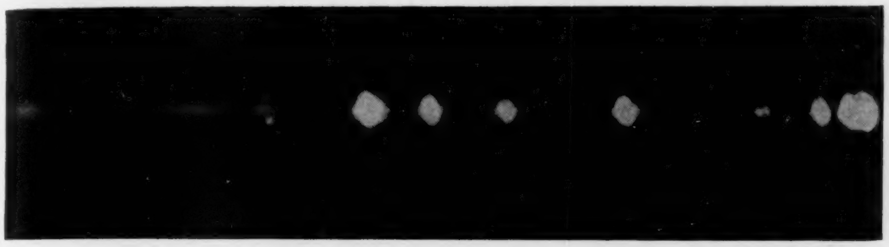
BEGINNER'S PAGE

By Percy W. Witherell

SPECTRA — III

Giants and Dwarfs, Nebulae and Galaxies

Last month we noted that stars of low density (giants and supergiants) can often be distinguished from high-density (dwarf) stars of the same spectral class by the sharpness of the lines in the spectra of the former when compared with the broad, fuzzy lines, particularly of hydrogen and helium, in the dwarfs. This distinction was the basis of Miss Antonia C. Maury's classes *c* and *d*, proposed many years ago. Nowadays, this feature is indicated by placing these small letters before the usual spectral classification. Thus, the supergiant, Rigel, is designated as *cB*8, while the giant, Zeta Capricorni, is *gG*4, and the sun, a dwarf, is *d*G4. Spectra of the latter two appeared on page 8 last month.



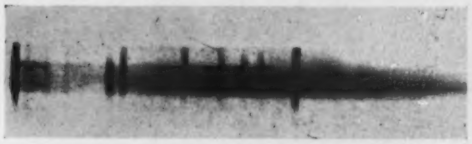
A slitless spectrogram or prismatic photograph of the planetary nebula, N.G.C. 7009. At the extreme right are the two largest images, almost coalesced, formerly attributed to nebulium, and now known to be produced by doubly ionized oxygen (OIII). They are of wave lengths 5007 and 4959, with the image of H Beta (4861) next to them. This nebula is 3,000 light-years distant, its radius is 780 billion miles, and its mass 1/12 that of the sun.

It is generally true that the supergiant (*c*) characteristics can be readily distinguished in stars from *B*o to *M*, whereas the difference between *g* and *d* is usually not clearly seen in classes earlier than *F*. This latter distinction is based on differences in the relative intensities in the lines of certain elements, such as ionized strontium, which appear strong in giant stars and weak in dwarfs.

The effects of density and temperature on spectra are also important in the study of the gaseous or diffuse nebulae. Their spectra may be of two kinds. The Orion nebula produces primarily emission lines of hydrogen, helium, and doubly ionized oxygen. The wisps of nebulosity surrounding the famous Pleiades have a dark-line spectrum similar to that of the stars themselves.

The nebulae which show emission spectra are near very hot *O* or early *B* stars; these give off relatively large quantities of ultraviolet radiation which excites the atoms in nearby nebulae to shine. The nebulae which have dark-line spectra are shining by reflecting the light of associated cooler stars, and these do not give off enough ultraviolet radiation to cause noticeable bright lines in the nebular spectra. The reflection is chiefly from the dust particles which, together with atoms of various elements, compose the diffuse nebulae.

Planetary nebulae are gaseous also, but they have a more-or-less elliptical appearance and usually surround a very hot central star. Some of them have complex structure; spectrograms taken without using a slit (prismatic photographs) show that the gases composing them are distributed in "shells" or layers of differing density and temperature. Very long exposures reveal that there is also some reflection of light from the central star. The average planetary nebula is a great, glowing vacuum with a diameter of about 10,000 astronomical units, and a mass about

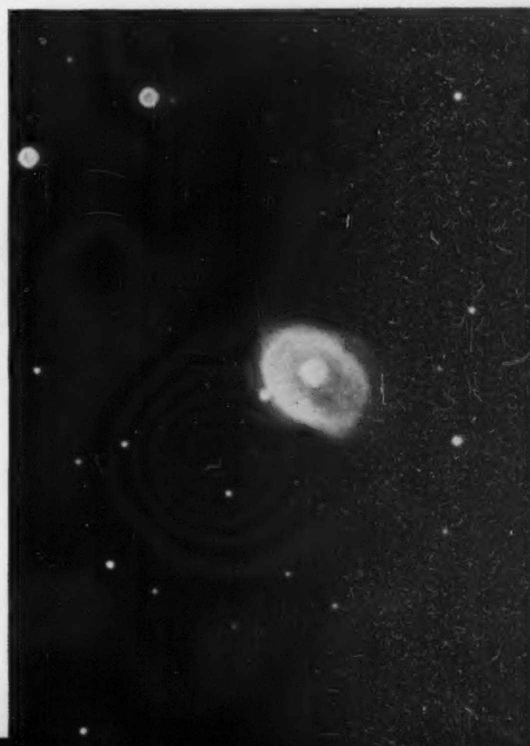


The spectrum of the Orion nebula is a combination of bright lines and a continuous, reflection spectrum. The bright lines are produced by ultraviolet energy obtained from two of the stars in the Trapezium having temperatures of 25,000° C. or higher.

1/10 that of the sun, but located many thousands of light-years away in our galaxy. Some central stars have surface temperatures as high as 100,000 degrees centigrade.

For a long time, the strongest lines in nebular emission spectra could not be identified in earthly laboratories, and the element producing these lines was tentatively named nebulium. The mystery was solved, however, in 1927 by Dr. I. S. Bowen, of the California Institute of Technology, when he showed that these lines were produced by ionized oxygen. Together with nitrogen, this element accounts for most of the bright nebular lines.

When our spectroscopic observations are extended beyond the galaxy to those other "nebulae," the external galaxies, the stellar character of these bodies is revealed. Their spectra appear to be of the *G* type, similar to that of the sun, composites of the light of the stars making up the galaxies. In a few cases, the external galaxies have *A*-type spectra, and the central portions of some systems give emission spectra. Many emission patches are found in various regions of the late-type or open spirals, such as in M33 in Triangulum.



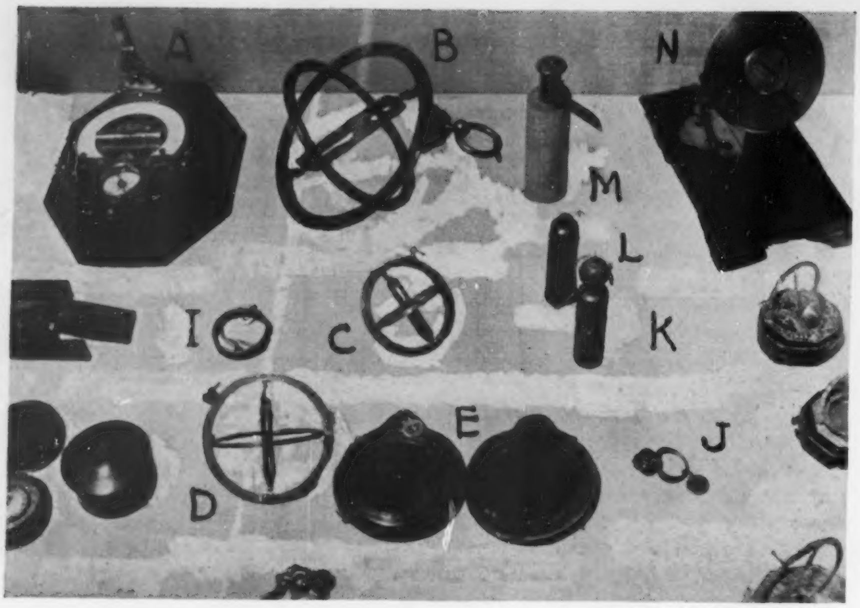
The nebula, N.G.C. 3132, is known as the "8-burst planetary," and illustrates the complexity of the structure seen in some planetaries. It is not known just how the numerous shells were originally formed around the central star. This photograph was taken at the Boyden station of Harvard Observatory.

MEXICAN ACADEMY HONORS HARVARD SCIENTISTS

In July, three Harvard scientists who recently attended a conference on physics in Puebla, Mexico, were elected correspondent academicians of the Mexican Academy of Sciences, the Antigua Sociedad Cientifica Antonio Alzate. They are Dr. P. Bridgman, physicist, Dr. L. C. Graton, geologist, and Dr. Harlow Shapley, astronomer. Their election is considered an important step in the furtherance of closer cultural relations between Mexico and the United States.

COLLECT
IN T

By R. Newton May



A corner of the Ernst collection shows a number of different types of dials. A, HORIZONTAL—porcelain dial plate; B, C, D, ARMILLARY, Universal, Light; E, ARMILLARY, Universal, Light—collapsed in shagreen case for carrying; I, VERTICAL (Altitude) Light; J, EQUATORIAL—see accompanying full-size illustration; K, L, M, VERTICAL (Altitude); M was illustrated on page 6 of the August, 1943, issue; N, EQUATORIAL—has unequal hours; for details, see page 5, August issue. These dials are classified by the Mayall system. Several illustrations in this and the preceding article are by courtesy of the Harvard "Alumni Bulletin."

IN THE past few years, I have received so many requests for information concerning the location of sundial collections in the United States that I take the opportunity to supplement the article, "Know Your Sundials" (*Sky and Telescope,* August, 1943), with this list of collections that have come to my attention, as of July 1, 1943. Private collections have been included as a matter of record, for they show a widespread interest in sundials as a hobby—an interest that is increasing steadily. I am indebted to the respective curators and owners for the information contained in the following list. Any omissions are unintentional. I shall be happy to hear of other collections.

Collections Open to the Public

CONNECTICUT

F. Richard Bolster Collection, Bristol. An excellent collection of copies of historic and interesting sundials, together with a few nocturnals and astrolabes. All instruments (about 30) were made by the owner. They may be seen in the museum (open on request only) on the top floor of the Bristol Public Library. An inquiry at the delivery desk will admit visitors to the collection, without fee, at any time during library hours.

In addition to the above, Mr. Bolster has also given and loaned several instruments to the University of Vermont (see below).

George E. Reynolds Collection, "Marine Museum and Shop," Boston Post Road, Saybrook. A diversified group including surveying and nautical instruments, sundials, and watches. There are about 45 portable sundials covering the period from around 1500 B.C. to the present. Many of these dials are copies and made by the owner. Also, there are several nocturnals and models of larger dials. Open to the public any time without fee. For visitors who are unable to view the collection during the day, a previous telephone appointment will be appreciated.

DISTRICT OF COLUMBIA

United States National Museum, Washington. A collection of sundials (22 portable, 30 stationary), covering the period from the 17th century to 1917, is housed in the Arts and Industries Building, which is open to the public, without fee, 9 a.m. to 4:30 p.m. daily; and 1:30 p.m. to 4:30 p.m. on Sundays.

ILLINOIS

Mensing Collection, Chicago. One of the finest collections of astronomical instruments in the world. Located in the Adler Planetarium. More than 400 instruments are on display, of which about 175 are sundials of all sorts. Many of them are intricate devices containing gears, lenses, and so forth. It is representative of the finest work done in the period 1479 to 1800. Entrance fee.

Museum of Science and Industry, Jackson Park, Chicago. A few portable dials, and a replica of a signal gun dating from about 1650.

John C. Tomlinson Collection, Chicago. Located in the Adler Planetarium. A small collection of 17th- to 19th-century instruments. Outstanding among them are the dials by Schissler, Christopher Wren, and Thomas Jefferson. Entrance fee.

MASSACHUSETTS

Nathaniel Bowditch Collection. This collection is divided into two parts. **Part I** is located in the Peabody Museum, in Salem. Nathaniel Bowditch is particularly well known for his **American Practical Navigator,** which is, even today, a standard reference work on navigation. Many of the Bowditch manuscripts and marine instruments together with a few sundials are on display. Open without fee, weekdays, 9 a.m. to 5 p.m.; Sundays, 2 p.m. to 5 p.m. **Part II** is in the Transparency Room at Harvard College Observatory, Cambridge. Several instruments made by Nathaniel Bowditch are on display, together with a Gunter's quadrant (sundial), an astrolabe, a nocturnal, and other instruments used by Bowditch. There is also a horizontal dial made by his son, Ingersoll, at the age of 16.

Harold C. Ernst Collection, Cambridge. Located in the Transparency Room at Harvard College Observatory. A fine collection of more than 150 portable sundials, covering the period from the 16th century to 1921. Particularly notable for its Oriental sundials, the largest group of its kind in the world.

Essex Institute, Salem. Here is preserved, in the museum, what is considered to be the first sundial in America. This small hexagonal dial, about five inches across, was made by William Bowyer in London in 1630, for John Endicott, who lived in Salem at that time. Open without fee, weekdays, 9 a.m. to 5 p.m.

Harvard College Observatory, Cambridge. Several collections are exhibited in the Transparency Room. Permanent exhibitions include the Harold C. Ernst collection of portable sundials (see above), and the Wheeler Willson collection of instruments. Loan collections include the Yalden collection (see below), a portion of the Mayall collection (see below), and a portion of the Bowditch collection (see above). A small case is devoted to temporary exhibits, wherein have been displayed the Walker collection (see below),

A jack-of-all-trades is this CONCAVE dial. The instrument is 7 x 2½ x 1 inches. It was made in Japan, of olivewood, and contains, in addition to the small hemispherical dial, an inkwell, a compass, an abacus or counting apparatus, a brush for writing, a small pair of scissors, an awl, stylus, and knife.

TIONS OF SUNDIALS
THE UNITED STATES

MA *In charge of the Ernst Collection, Harvard College Observatory*

An interesting and rare piece of jewelry, an EQUATORIAL dial mounted on a finger ring. The lower photo (full size) shows it in position for use; the upper picture (two times full size) shows the small compass. The dial plate folds down over the compass, and the solid piece folds over the dial plate, protecting it when not in use.

a portion of the Bolster collection (see above), a portion of the Forbes collection (see below), and other instruments of an astronomical character. The collections are open to the public without fee, upon request.

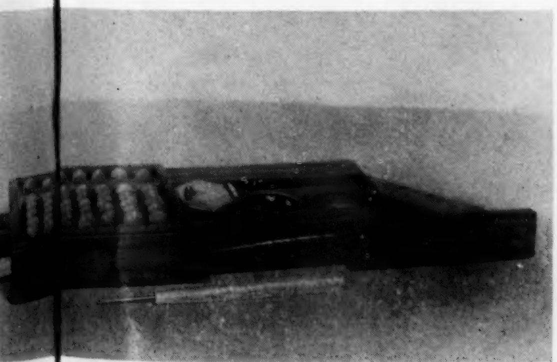
Peabody Museum, Salem. A small but interesting collection of five sundials, 10 sand glasses (including a 14-second and a 28-second log glass), one astrolabe, four nocturnals, and a lunar calculator, representing the period from about 1650 to 1850. The instruments are displayed in Academy Hall Corridor. A portion of the Nathaniel Bowditch collection (see above) is also located in this building. Open without fee, weekdays, 9 a.m. to 5 p.m.; Sundays, 2 p.m. to 5 p.m.

J. Ernest G. Yalden Collection, Cambridge. Located in the Transparency Room at Harvard College Observatory. The collection contains about a dozen replicas of larger dials designed by the late J. Ernest G. Yalden, of East Orange, N. J. (See Harvard College Observatory.)

NEW YORK

James Arthur Collection of Clocks and Watches and **James Abbot Collection of Watches,** New York University, University Heights, New York City. These famous collections became the property of New York University in 1926, and are now exhibited in the Library, on the campus. Here will be found 180 clocks, 1,400 watches (200 from the Abbot collection), and two sundials. This is the largest collection of its kind in this country, and one of the finest in the world. It includes clocks and watches of every description gathered from all parts of the world. Due to the present temporarily cramped condition of the exhibition room, the curator suggests that visitors seek an appointment. The collection is open to the public without fee, afternoons only, each day except Sundays and holidays.

Hayden Planetarium, 81st St. and Central Park West, New York City. A loan collection of about 50 sundials, mostly portable, contained in wall cases in the corridors. Entrance fee.



Metropolitan Museum of Art, 5th Avenue, New York City. This collection has been retired from exhibition for the duration of the war; but photographs of the dials may be examined and procured at the information desk. The character of the collection is similar to that of the Mensing. There are in all 55 portable dials, eight stationary dials, 78 clocks, 500 watches, one astrolabe, five calendar dials, a graphometer, and seven nautical instruments, covering the period from 1560 to about 1890. There is also a sundial represented in the Boscoreale Fresco in Gallery D 10, and in the Department of Egyptian Art a dial is displayed in Gallery H 2. Open every day. (Due to changing conditions, visitors should check the times of opening.)

David Eugene Smith Collection, Columbia University, New York City. Located in Room 210, in the Low Memorial Library. A diversified group, including astronomical, surveying, and drawing instruments, numbers games, and many odd pieces such as lucky charms and "knotted cords." There are 285 pieces, of which 54 are sundials of various kinds, covering the period from 1450 to 1900. In the same room are many early books relating to the sundial and other early scientific instruments. Open without fee, Mondays through Fridays, 9 a.m. to 5 p.m.; Saturdays, 9 a.m. to 12 m.

PENNSYLVANIA

The Franklin Institute, Benjamin Franklin Parkway, Philadelphia. Located in the Hall of Astronomy on the second mezzanine, in the Museum. A small but excellent display of timekeeping devices and other astronomical instruments. Of particular interest is the working scale model of the famous Strasbourg Clock. Here also is an astronomical observatory containing two large telescopes. Due to changing conditions, visitors should check times of opening. Entrance fee. (The observatory is open every clear evening to visitors to the Fels Planetarium.)

Hamilton Watch Company, Lancaster. A selected group of replicas of old timepieces including the time lamp, signal gun, time candle, water clock, and several sundials. This is a traveling exhibit for store use, designed for educational purposes and to show the various methods used to tell time before the advent of the watch and clock.

VERMONT

F. Richard Bolster Collection, University of Vermont, Burlington. A variety of copies of old dials of the period 225 B.C. - 1700 A.D. will be found in the Fleming Museum. The collection was made by F. Richard Bolster (see above) and includes card, quadrant, ship, and pillar dials; several astrolabes and other interesting items. A few of the pieces have been loaned for an indefinite period by Mr. Bolster. Open without fee, weekdays, 9 a.m. to 5 p.m.

Private Collections

CALIFORNIA

Charles R. Delaney Collection. A small collection of portable and stationary sundials, and clocks, representative of the period 1619 - 1837.

William Barclay Stephens Collection. A large and noteworthy collection of sundials, clocks, and watches, from 1639 to about 1900.

CONNECTICUT

F. Richard Bolster Collection. An excellent collection of copies of historic and interesting sundials, together with a few nocturnals and astrolabes. All instruments (more than 75) were made by the owner. A portion of the collection has been loaned to the Bristol, Connecticut, Public Library and to the Fleming Museum, University of Vermont (see above).

Harry B. Dorr Collection. A fine group of homemade dials executed in brass, copper, and bronze. All are etched. Includes many different forms and types enhanced by the excellence of their design and workmanship.

IOWA

Charles F. Noe Collection. A small but fine collection of selected signed instruments (portable) of exceptional workmanship, of the period 1600 - 1800.

MASSACHUSETTS

Lester T. Forbes Collection. A small collection of portable and stationary sun-

dials representing the fine workmanship of the period 1631 - 1800.

Mayall Collection. A small collection of portable sundials including replicas of historic dials, and other instruments used for timekeeping. A portion of the collection was made by the owner, who has loaned some instruments to Harvard College Observatory (see above).

Frederick A. Stebbins Collection. The main portion of this collection comprises stationary and portable sundials made by the owner, who displays ingenuity in the application of various methods of telling time.

Richard D. Walker Collection. A few selected signed portable sundials of the period 1592 - 1700.

NEW JERSEY

Laurits Christian Eichner Collection. The owner, a craftsman, has made many fine replicas of famous instruments, including water clocks, sand glasses, time lamps, time candles, sinking bowls, sundials, and early astronomical instruments. Many items from this collection are on display at the Hayden Planetarium in New York City (see above).

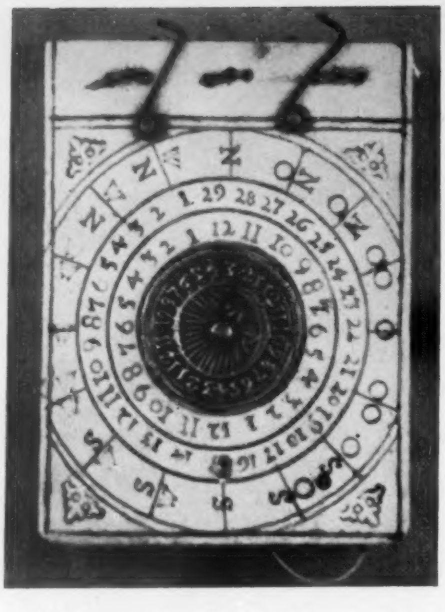
Albert E. McVitty Collection. A fine collection of portable sundials, mostly French (18th century), with several German (17th century). Also Mausard's (architect of Versailles) own silver sundial, with his coat of arms. Representative of the finest craftsmanship of the period.

NEW YORK

L. Prescott Brown Collection. Contains many interesting portable and stationary dials made by the owner.

Lester F. Hoyt Collection. A group of stationary dials of various types, made by the owner. All are etched.

Henry Russell Wray Collection. An excellent collection of about 100 portable sundials, covering the period 1460 - 1926. Also includes astrolabes, perpetual calendars, and sand glasses.



HORIZONTAL-VERTICAL—France, about 1650. Here is pictured the back of the vertical tablet of this ivory dial, which is fitted with a lunar calculator.

PENNSYLVANIA

Harrold E. Gillingham Collection. One of the finest collections of portable sundials, comprising about 250 pieces; also sand glasses, astrolabes, an orrery, time lamps, and mathematical instruments. Period, 1548 - 1930.

John R. Lambert Collection. Many interesting portable and stationary dials made by the owner, who ingeniously incorporates various methods of telling time into his designs.

Letter to the Editor

Sir:

I am interested in sunspots and have a look at them every day that it isn't cloudy. As I don't go to work until nine o'clock, I usually have a look in the morning. I use a 4¼-inch richest field of 20½-inch focal length, which I made, setting it up just outside the garage door to project the image on a screen at the inner wall. The image is three feet in diameter, so that if there is a spot on the sun it shows up plainly.

If I want to use this arrangement at noon, I just put the telescope into position and reflect the image to the screen by using a flat mirror just about an inch from the eyepiece.

About eight years ago I saw my first sunspot, using an 8-inch, f/8 reflector. I purchased a 40-mm. disk of Noviweld glass No. 14, and mounted it just back of the diagonal toward the mirror—the second time I used it, it split from the heat. So I ordered another one and diaphragmed the tube down to only three inches; I had no more trouble for about two years, when one day I forgot the mask and the disk broke again. With the richest field, I also use the Noviweld glass, but have no trouble from breakage.

One doesn't always need a telescope or dark glass to see sunspots. When my garage is closed it is quite dark inside, and in the winter, when the sun is low in the sky, I have seen sunspots on the inside of the north door—the image of the sun being formed by light coming through a pinhole in the south wall. The image is about four inches in diameter and the spots are quite plain.

There seems to be a definite relation between sunspots and the weather down here. I have a 20-inch cross-section of a tree that was cut down five years ago. The tree was close to 90 years old and there are three distinct wide circles with 10 circles between. The hotter weather during those years, separated by 11-year intervals, shows the association of the weather with sunspot activity. It seems to get hotter here when spots are most numerous—in September of 1928 it was only 107° in the shade.

B. L. HARRELL
Gadsden, Ala.

Ed. Note: On the "Observer's Page" this month, Mr. Fitzpatrick discusses the observation of sunspots, which are now beginning to increase in size and number.

SPECTACULAR FIREBALLS

TWO letters recently received by the editors report observations of bright fireballs. We quote in part from them. The first is from Fred M. Garland, past president of the Pittsburgh amateur group, and now assistant director of Leo Scanlon's Valley View Observatory, 106 Van Buren Ave. 14, Pittsburgh, Pa.

"At 9:20 E.W.T. this evening (July 30, 1943), I saw a most beautiful fireball in the northwestern sky. I was walking down our driveway at home, and like many an amateur astronomer, was 'looking up.' Suddenly this elongated, pear-shaped, blue bulbous light with whitish tail streaked downward, something like a Roman candle going the wrong way. A guess of the elapsed time of visibility would perhaps be two seconds. It thinned out rapidly, and I would say the length of flight was 15°, or a little more. The position in full luminosity was approximately 6° to the west in azimuth of Beta Ursae Majoris and 8° directly down toward the horizon from Gamma Ursae Majoris.

"My greatest regret is that I did not have a camera pointed in that direction, for the picture, had I been fortunate enough to get the correct exposure, would have resembled that very fine photograph sent to us at Valley View Observatory from the Texas Observers some time ago."

From D. C. Wysor, New York amateur and owner of a fine private observatory at 136 Brookside Ave., Ridgewood, N. J., comes record of "a passing incident, but one the like of which I never before beheld. It was seeing a meteor in broad daylight about 1½ hours before sunset, July 21, 1943.

"At this time I was on the Missouri prairies some 90 miles west of St. Louis. It so happened that at the moment of visitation by our celestial wanderer, I was looking up into the clear northern sky in which it appeared. I took it to be of the fireball type. It certainly would have lit up the heavens on any dark night. It looked like a bright arc light, and was visible for probably not exceeding one second. At least the suggestion of a tail showed. I estimated roughly that it was traveling north by some 10° west, and appeared about 45° above the horizon.

"Common as meteors are, the sight of this fellow started me to thinking—why are they not more often seen in daytime? Perhaps they are, but I am past 50, and this is my first experience with 'daylight bombing'! Of course, you wouldn't expect to see the little ones, but it seems to me that there ought to be enough of the more spectacular flights to catch the eye now and then even in the brightest sunlight. What do you say?"

Amateur Astronomers

THE ASTRAL SOCIETY

THE Astral Society, an organization of teachers and students at the Eastern Mennonite School at Harrisonburg, Va., was founded by six charter members in 1930. By May, 1943, the membership totaled 246; in late years, the active membership has been around 45.

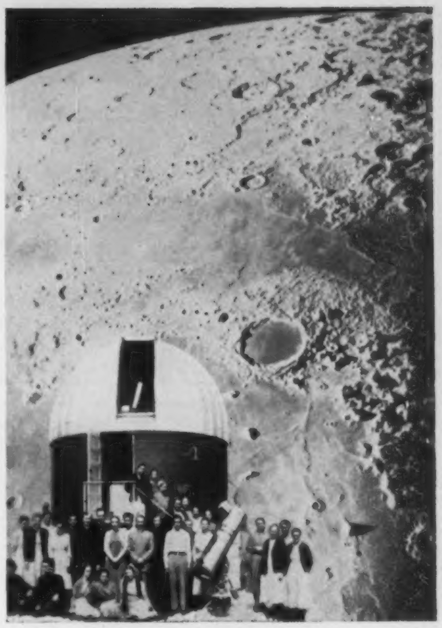
A candidate (Asteroid) becomes a member when he has identified 12 celestial objects and has paid one dollar, which is a life membership fee. He then signs the constitution, chooses a star name, and receives a certificate of membership. He is assigned 6th magnitude, and is given a green star opposite his name on the Astragraph. When he has named 25 objects, he is given 5th magnitude and a yellow star. He becomes a 1st-magnitude member and receives a gold star when he has identified 85 objects. If a member learns 85 new objects between the opening of the school year and the Christmas holidays, he becomes a Nova. In the spring a contest is held, in which the winner, the one who names and points out correctly the largest number of stars and constellations, receives the Astral award.

In the spring of 1938, the society sponsored the building of a 6-inch reflecting telescope. Samuel Nafziger, with some assistance from a few other members, ground and polished the mirror. With the help of Aldus Brackbill, he built a Springfield mounting. Just at that time, the 1938 graduating class was casting about for a suitable project for a class gift. Plans for an observatory were drawn up, and estimates of costs presented to the class, the members of which were pleased to pledge themselves for the estimated cost of the building. The Shenandoah Equipment Corporation, a Mennonite firm nearby, agreed to build the dome on a cost basis.

The hemispherical dome is 15 feet in diameter, and rotates on roller bearings. The slit cover is operated on a windlass. A solid telescope pier, independent of the building, was constructed. The furniture on both floors is curved to fit the circular wall. The upper floor is furnished with several tables, a lantern slide machine, and an illuminated display rack for slides. Below are a large table, a register desk, a cork bulletin board, and a display of pictures on the wall. Elevation of the observatory is 1,520 feet.

After the observatory had been in operation for awhile, a 12-inch reflector was purchased to take the place of the 6-inch, and more recently, a 6-inch Mogey refractor has been permanently mounted in the dome. It has a focal length of 90 inches, and magnifications from about 100 to 350. The instrument is equipped with setting circles and a motor drive. A small camera attachment, made to replace the eyepiece, can be used with the objective, and with it photographs of the sun, the moon, and the planets are taken.

When large groups are to be accommodated, all three telescopes are put into service. The two reflectors are mounted on tripods equipped with casters, and are wheeled out onto a platform for use. The 6-inch has a focal length of 60 inches.



"Who says nobody lives on the moon?" queries Mr. Brackbill, as he sends this photograph of a recent gathering of the Astral Society.

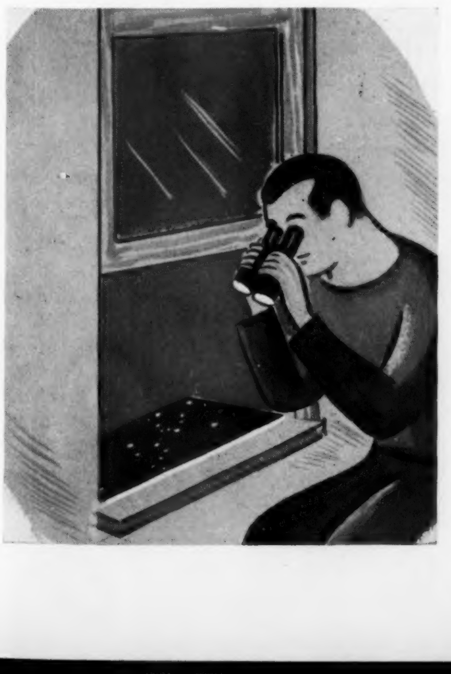
The 12-inch, built by L. A. Weaver, Kansas City, Kans., can be used as a Newtonian or a Gregorian. The focal length of the primary is 43 inches, but the effective focal length of the Gregorian system is about 250 inches. Magnifying powers up to 500x can be employed. This instrument is also equipped with setting circles and a motor drive. An f/2.5 Cooke 3-inch lens is mounted in a camera box at the upper end of the tube; the camera is used for photographing constellations and star fields.

Meetings of the Astral Society are held monthly, but the observatory is open by appointment to all interested. Engagements may be secured by communicating with the undersigned.

M. T. BRACKBILL, director
Vesper Heights Observatory
Eastern Mennonite School
Harrisonburg, Va.

WINDOW-SILL OBSERVING

ARTHUR ROSENBERG, advertising executive and member of the Amateur Astronomers Association in New York, finding limited use for his 3-inch refractor on an apartment house roof surrounded by all the handicaps that come to city observers, has added a new wrinkle, in the way of a window-sill reflecting observatory.



Outside of a small chest-high window, he has fastened a 2-foot-square shelf. On this shelf he places a distortion-free plate glass mirror. Seated on a high stool, he is able to observe a fairly large section around the zenith. For this purpose he uses anything from a 3x opera glass to a 25x short-focus telescope. The limitations placed upon the field covered by the mirror are to a large degree offset by the comfort the observer enjoys through this method of constellation study, and in the observation of such clusters, binaries, and other sky exhibits as can be amplified by the power he is able to apply to the mirror.

This observatory proves a great convenience on cold winter nights, as well as on clear windy nights when a small 'scope suffers from vibration.

LETTER TO THE EDITOR

Sir:

I am nine years old. My birthday was on July 6th, and I thought it was a nice birthday treat to get to see Venus in daylight.

I started studying astronomy about March 1st. First my mother got me a little book called *Seeing Stars.* It had most of the constellations in it, but it didnt have Vulpecula, Sextans, Scutum, Lacerta, and some of the other faint ones. Also we got books from the library.

JOHN WALTON
Station A, Ames, Ia.

BOOKS AND THE SKY

NAVIGATION

J. C. Kingsland and **D. W. Seager.** Oxford University Press, New York, 1943. 95 pages. $1.00.

PERHAPS time is the most important factor in teaching navigation in the Services. In some courses prescribed for student flyers, it is desired to have the student obtain a quick introduction to the subject, especially as navigation concerns problems of flight. It is for this purpose that the Kingsland-Seager book is written, so that a reviewer may not justly criticize it as being incomplete or sketchy.

These 95 pages are written in an easy, simple style, with well-drawn diagrams, making a first, rapid reading possible in just a few hours. Then, a student ought to be able to sit down to work the exercises at the ends of the chapters and take no more than a day to do all of them. Such an "introduction" to aerial navigation (the title of the book is incomplete, and therefore, misleading) will then have required about 12 or 15 hours of a student's time.

As suggested in the publisher's jacket note, this book might become a "handbook" for one who carefully studied every line, but it would be far from "ideal" for the purpose. Rather, it seems to me that the material it covers ought to be so well known by anyone concerned with flying that he would need no written reference on matters of such fundamental value.

After discussing the form of the earth, maps and charts, and the compass, in their first three chapters, the authors explain the relation of weather conditions and weather analysis to the use of the altimeter and the air-speed indicator. There is a surprising amount of information in relatively few pages. The concluding chapter, entitled "Dead Reckoning Navigation," would give a seaman practically no knowledge of the subject as practiced by surface vessels, but from the airman's viewpoint, it is a very concise account of the simpler problems concerned with course, track, wind, radio bearings, and interception assignments.

The book is British throughout, but its references to English charts should help the student who may some day fly in the United Kingdom. We suggest that these same authors produce a full-sized aerial navigation text, somewhat more in the American style. This would probably be a valuable and lasting contribution to the rising number of publications on navigation.

C. A. F.

SEXTANT AND SAILS

The Story of Nathaniel Bowditch. **Robert Elton Berry.** Dodd, Mead and Company, New York, 1943. 231 pages. $2.50.

THE appearance within a year's time of two lives of Nathaniel Bowditch written for children is rather extraordinary. It doubtless is a sign of an increased interest in seafaring stories, and is surely a good thing for young readers. They are always eager to read a second book on a subject they have enjoyed once.

For children of 10 or less, Mrs. Tharp's **Down to the Sea** will perhaps be a little easier reading than Mr. Berry's book.

Sextant and Sails is by the author of **Yankee Stargazer**—a biography of Nathaniel Bowditch written for adult readers. There can be no doubt of its historic accuracy, and it gives a clear picture of the life of that time. The contribution of Bowditch to navigation, then and now, is forcefully presented.

The style is easy and conversational, so that there is no loss of interest. The book is attractively printed, although illustrated in rather a sketchy fashion.

PRISCILLA F. BOK
Harvard College Observatory

NOTE TO THE EDITOR:

Mr. George A. Davis, Jr., of Buffalo, N. Y., has called my attention to an error on page 2 of the book, **Atoms, Stars, and Nebulae.** To the Persians, Sirius did not represent a dog; he was called Tishtrya, the great Rain-star who battled Apaosha, the demon of drought. The incorrect allusion to Sirius as the guardian of the bridge of Kinveh was based on an early or poor translation of the **Avesta-Zend,** the bible of the ancient Persians.

L. H. ALLER

ASTRONOMICAL ANECDOTES

LASSELL, SATELLITES, AND THE DEATH OF A GREAT TELESCOPE

LIKE most astronomical journals, our estimable contemporary, *Popular Astronomy,* which recently celebrated the beginning of its Vol. 51, had several immediate ancestors. First was the *Sidereal Messenger* (not the one founded by O. M. Mitchel), which ran for 10 volumes, beginning in 1882. Following it, there were three thick volumes of *Astronomy and Astrophysics,* which was the father of both the *Astrophysical Journal* and *Popular Astronomy.*

In the *Sidereal Messenger* for 1884, we find it reported that, a year earlier, "the Misses Lassell kindly placed a 7-foot Newtonian reflector at the disposal of Professor William Huggins of England, to aid in photographing the solar corona. Between April 2 and September 4, fifty photographs were taken, all of which show a coronal appearance, in some of these pictures proved genuine as far as 8 minutes of arc from the Sun."

Needless to say, the "appearance" was not truly coronal. Sir William Huggins, a great pioneer in so many matters astrophysical, was also one of the first who early tried and failed to photograph the corona without an eclipse. The telescope used for the purpose was either a 7-inch or a 9-inch reflector made by William Lassell (1799-1880), who later made fine 24-inch and 48-inch reflectors. Lassell was very ingenious in mounting his instruments. As early as 1840 he had mounted his 9-inch Newtonian reflector equatorially, and evoked from Sir John Herschel the comment that the accomplishment marked an epoch in the history of "that eminently British instrument, the reflecting telescope." The mounting of his 48-inch reflector was of the fork type, hence, far superior in operation to the large instruments of Herschel and the Earl of Rosse; attached to it was a gear train to be turned by the hand of an assistant, who kept his turning synchronized with the beat of a pendulum!

In 1877, writing from Ray Lodge, Maidenhead, Lassell had this to report: "In answer to the inquiry respecting my great telescope, I may say that it does not now exist. After keeping it several years, dismantled, and the mounting necessarily depreciating, and, moreover, being persuaded that it would never be remounted by me, I ultimately consigned the cast and wrought iron-work to the furnace and tilt-hammer of the engineer, and the specula to the crucible of the bell-founder. I may add that when witnessing the breaking up of the specula, I was not without a pang or two on hearing the heavy blows of sledge-hammers necessary to overcome the firmness of the alloy; and the expressed admiration of the bell-founder on seeing the whiteness, brilliancy, and compactness of the metal as revealed by the fracture."

This was not the telescope used to discover "the most difficult satellites of the solar system." It was with his fine 24-inch reflector, mounted at "Starfield," near Liverpool, that Lassell discovered Ariel and Umbriel, the two inner satellites of Uranus, on October 24, 1851. With the same telescope, he had sighted Triton, the satellite of Neptune, only 17 days after the discovery of the planet itself by Galle, of Berlin. And it was with the same telescope that he saw, on September 18, 1848, and recognized as a satellite to Saturn on September 19th, the body we call Hyperion. It was a remarkable coincidence that W. C. Bond, with the 15-inch refractor at Harvard, had caught sight of the same object on September 16th, and also decided it to be a satellite on September 19th.

The 24-inch reflector, of 20 feet focal length, was taken by Lassell to Malta, in 1852, where he was in search of better skies than those of England. There, in 1860, he mounted his great 48-inch instrument, the death of which he so vividly describes in the passage quoted above.

Then there came talk of a large telescope for the Melbourne Observatory, just about the time Lassell wished to return to England, after having discovered 600 nebulae in two years. He offered his instrument, but the offer was declined, apparently through some kind of official stubbornness, and the crowning blow was added when an instrument of the same size was ordered for Melbourne from Thomas Grubb (father of Sir Howard) in 1867. This act met with considerable criticism from the capable astronomers of England, who knew Lassell and his instruments, and were dubious of an attempt to duplicate such a great telescope. But when the Melbourne 48-inch reflector (with a perforated primary—the first large Cassegrainian) was delivered in 1870, the critics had their revenge; the mirror's polish was quite inferior, and, indeed, the instrument never did function very well. It would have been better to have accepted Lassell's gift; it was largely from chagrin at the outcome of this matter that Lassell decided to destroy his telescope.

Next month, I'll give something old and something new about the satellites of Uranus. R.K.M.

GLEANINGS FOR A. T. M.s

Setting Circles

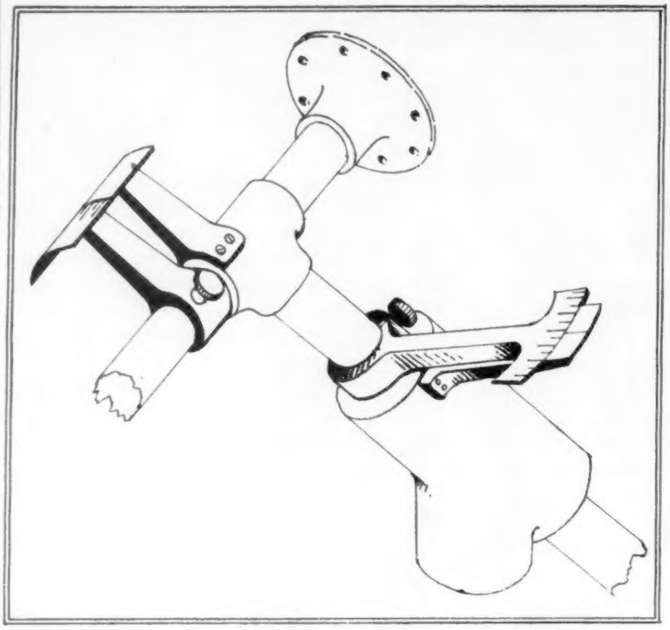
THE writer has issued, for the past two years, a set of information sheets on the practical use of the telescope by amateurs. During that time, he has been in touch with many telescope users and has reached the conclusion that most of them do not have setting circles on their instruments.

The reason for this is not hard to find. In the first place, it is admittedly difficult to graduate the circles with a good degree of accuracy, especially if an expensive dividing head is not available. In the next place, directions for the proper numbering and use of such circles are difficult to find. An article, by Leo Scanlon, in **Amateur Telescope Making** does outline a method of graduating circles, which, although the process is a bit tedious, could be successfully followed by any telescope maker having access to a lathe; but the directions for properly numbering and using the completed circles, as given by various writers in the same book, are conflicting and confusing. This remark applies especially to the numbering of the declination circle. I find very little anywhere about the function, proper numbering, and use of the circle on the polar axis.

Suggestions for adjusting the polar axis of an equatorially mounted telescope appear in **Amateur Telescope Making Advanced,** but the authors say nothing of the possible variation in methods of numbering the setting circles. Each apparently assumes that all circles are numbered just as his are. It is true that the simplest and most satisfactory method of numbering a declination circle is with the numbers running from 0 to 90 degrees in each direction from two points opposite each other on the circle, but other methods of numbering are suggested in **Amateur Telescope Making.**

The circle on the polar axis may be numbered as an hour circle, with readings increasing in value from 0 to 24 hours as the telescope is swung toward the west about the polar axis, or as a right ascension circle, with readings increasing as the telescope is swung toward the east. The former method is the traditional one, but the latter is growing increasingly popular with amateurs.

With the circle on the polar axis numbered as a right ascension circle, it may be built with a friction fit on the axis and may then be set to read the right ascension of any celestial object of known right ascension when the telescope is directed toward that object. The telescope may then be turned to the reading corresponding to the position in right ascension of any other body whose right ascension is known.



The use of friction-fit adjustable segments, which are to be read differentially after setting on an object of known position, will aid the amateur in speedy use of his telescope. The drawing illustrates two variations of design in the segments.

The friction-fit right ascension circle is a great convenience on telescopes which are not permanently mounted because of the lack of suitable housing or because they must be moved about to get a view of different portions of the sky. In such cases, the declination circle might also be adjustable through a small range of angle. The circles may then be used **differentially** by setting them to read properly when the telescope is directed to an object of known right ascension and declination in the near neighborhood of a faint object which is to be located. Even with the polar axis in very rough eye-estimate alignment, a setting on the known right ascension and declination of the object sought will usually bring it into the field of view of a low-power eyepiece. The **American Ephemeris** lists stars which may readily be used for reference objects.

It has occurred to the writer that for differential use, as outlined above, it is unnecessary to have complete circles. Short sectors of circles, a few degrees long, may be carried on movable arms[1]

[1]Such arms might be very conveniently made from old piston rods. Ed.

which are capable of being clamped at any angle to an axis so that the graduated sector may be brought under a fixed index when the telescope is set on the reference object. The telescope then need only be moved in the proper directions and by amounts equal to the known differences between the right ascension and declination of the reference object and those of the object sought.

It is not necessary to number the graduated arcs, since the few degrees, or the few minutes, of change necessary can be easily counted off. Furthermore, for such short arcs, the length of the divisions, in millimeters or in inches, may be calculated with all necessary accuracy from the relation that the arc is equal to the angle in radians times the radius. The scale may then be drawn accurately on paper and cemented to the face of the arc. The graduated arc may be either on a flat plate attached to the end of the movable arm, or the arm may carry, as it were, a portion of a rim of a wheel with the graduated face at right angles to a line drawn from it to the axis. The construction of a short arc offers little difficulty, since a slight departure from true curvature is immaterial. For permanence, the lines could be etched or carefully scratched on the rim of the arc.

An arrangement of the sort just described is within the reach of any amateur and should return good dividends in the easy location of faint comets and asteroids, or in the rapid identification of variable star fields.

G. B. BLAIR
University of Nevada

Sauce for the Gander

READERS are asked to send in questions, from which this editor will select the best each month to answer here. The last question is left unanswered, but the reader should be able to find the answer for himself. This month's questions come from Raymond E. Taylor, James P. Babbitt, and Caryl Annear.

Q. Is it a fact that there is no such thing as daily or diurnal libration of the moon at the north and south poles of the earth?

A. Yes. Daily libration of the moon results from the fact that the observer is carried around the earth every 24 hours and thus sees around the moon a bit at the extremes to which he is carried. These extremes depend primarily upon the observer's distance from the earth's axis, or the cosine of the latitude, and this is greatest at the equator and zero at the poles. The declination of the moon is also a factor; in fact, the change in the moon's declination produces libration in a north-south direction, also, and that is still observable at the poles.

Q. Every so often I have come across a term in **Sky and Telescope** such as "about 10^{10} the mass of the sun." I presume you have a table of figures and you could tell me how much is 10^{10} in long hand? If you do not have such a table and it would require time to figure it out, just don't bother with it.

A. No, it's no trouble to figure out. Just write the digit one and follow it with as many zeros as are indicated by the exponent. So 10^{10} is 10,000,000,000 or 10 billion, and 10^1 is 10. This simple and space-saving method of writing large and small numbers is extensively used in mathematics. It facilitates multiplication and division of large numbers because the exponents are simply added or subtracted.

The exponent expresses the power to which the number bearing it is to be raised. Thus, 2^2 is 4, 3^2 is 9, 5^5 is 3,125. But 10 is especially convenient as a base because all its powers bear zeros, as explained above. This enables us to handle numbers like 864,000, which may be written 8.64×10^5. Suppose we want to divide this number by 8,000, or 8×10^3. We divide the significant numbers and subtract the exponent of the denominator from that of the numerator. This gives us 1.08×10^2 or 108.

Negative powers of 10 are used to express numbers smaller than unity, as well as fractions. Thus 10^0 is 1; 10^{-1} is 0.1; 10^{-2} is 0.01; 468×10^{-6} is 0.000468. It is evident that these may all be written as the fractions 1/1; 1/10; 1/100; 468/1,000,000, respectively. In turn, they may be written: $1/10^0$; $1/10^1$; $1/10^2$; $468/10^6$. But 10^1 in the denominator is the same as 10^{-1} in the numerator, and so with the other cases. In other words, it is never necessary to use fractions to express a number if negative powers of 10 are used instead.

Q. What is meant by the magnitude of the sun and planets?

A. Magnitude expresses the brightness of an object on a logarithmic basis. Each magnitude is about 2.512 times as bright as the magnitude numbered one more than itself. The difference in brightness of five magnitude intervals is exactly 100 times, so a standard 1st-magnitude star would be 100 times as bright as a 6th. But very bright objects require negative numbers. Sirius is –1.6, Venus at greatest brilliance is –4.4, the moon, –12.6, the sun, –26.7. These numbers express apparent magnitudes as seen from our place in space. If all objects are placed at a standard distance of about 32.5 light-years, we compare their apparent magnitudes and call these absolute magnitudes. The sun appears then as a star of magnitude 4.85, so that number expresses its absolute magnitude.

Q. What is the absolute magnitude of the star, Sirius?

L. J. LAFLEUR

Gleanings for A.T.M.s is always open for comments, criticisms, and suggestions. We are here to serve, in every possible way, all the members of the telescope making fraternity — particularly in these days when a hobby may serve as welcome relief from the press of wartime duties.

SKY-GAZERS EXCHANGE

Classified advertisements accepted for this column at 30c a line per insertion, 7 words to the line. Minimum ad 3 lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard College Observatory, Cambridge, Mass.

DEEP-SKY WONDERS

THIS month finds the following objects in good position for observation with moderate-sized telescopes. Descriptions are from Norton's **Star Atlas.**

Draco. N.G.C. 6543, $17^h\ 58^m.6$, $+66°\ 38'$; a remarkable planetary nebula, with a very bright oval disk, and a central star of 9.6 magnitude. Nearly at the north pole of the ecliptic.

Vulpecula. M27, $19^h\ 57^m.4$, $+22°\ 35'$; the Dumbbell nebula, a planetary, elliptical with faint luminous notches.

Lyra. M57, $18^h\ 52^m.0$, $+32°\ 58'$; the Ring nebula, located one third of the way between Beta and Gamma; an interesting planetary for small telescopes; 80" x 60", with its central star visible only in large instruments.

Cygnus. M39, $21^h\ 30^m.5$, $+48°\ 13'$; a large, open cluster of bright stars, a good object for low powers.

STARS FOR SEPTEMBER

as seen from latitudes 30° to 50° north, at 10 p.m. and 9 p.m. on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

AIR AND SEA AND SKY

A department devoted to wartime subjects related to astronomy, such as aerial and celestial navigation, and meteorology.

THE COMPASS ERROR

IN GRAMMAR school, I had a science teacher who used to define mortar as "the stuff that holds bricks together and holds them apart." One can say almost the same thing with regard to the navigator's compass. The compass is useful because it always points north, but it causes a great deal of trouble because it hardly ever points north.

To begin with, the magnetic poles of the earth are not at the geographic poles; neither is the magnetic field of the earth uniform nor symmetrically placed in the earth. The effect of this is an error in the compass which is known as **variation.** The amount and direction of the variation are quite different in different parts of the world, and for a given locality the variation changes from year to year.

The value of the variation and the annual change are now given on mariners' and aviators' charts. At present, the variation at New York City is about 11° West; at San Francisco, about 18° East. The variation is named according to the direction in which the compass needle is deflected.

In the eighth edition of the **New American Practical Navigator** (E. & G. W. Blunt, New York, 1836), Bowditch gave the magnetic variation at 46 different localities, over half of them at sea. Today, we know the variation over the entire earth with a reasonable degree of accuracy.

Because of the paucity of information regarding variation, many early navigators ran into difficulty. Bowditch stressed the importance of checking the compass by "celestial azimuth," and from Edgar Allen Poe's **Narrative of A. Gordon Pym,** I suspect that the astute navigator followed this advice. Poe's tale is based, in part, upon the logs of contemporary whalers. Poe himself evidently did not know anything about variation, and a careful perusal of the **Narrative** shows that he probably thought it had something to do with the weather!

That many navigators, however, did not check the compass is shown by a statement written by S. T. S. Lecky in 1900 (for his **General Utility Tables,** Philip & Son, London, 1911 and earlier):

"Before stars were invented, Sable Island had undoubtedly an evil reputation: no end of crooked currents were floating about, and the island itself dragged its anchors all over the place; but the writer's experience proves it to have been a libel. NOTE: **The variation changes rapidly about here."**

A second error in the compass lies in the fact that all iron in the ship or plane will, to some extent, affect the instrument. Electric circuits also tend to introduce an error. The total error caused by forces within the craft is known as the **deviation.** Compasses are regulated at convenient intervals, and the deviation is minimized, as it is seldom possible to remove it entirely. A deviation chart is then made up listing the remaining errors on every 15° or 30° heading of the vessel, for the deviation changes with the heading. For intermediate headings, the deviation may be found by interpolation in the chart. If the data is in the form of a graph, no interpolation is necessary, the deviation being read directly from the curve.

Many factors affect the deviation, however. The intense heating of the ship's guns during action has been known to alter the deviation considerably. Similarly, when proceeding under forced draft, the boiler equipment may be overheated, with the same result. In commercial vessels, the type and disposition of the cargo will also affect the compass.

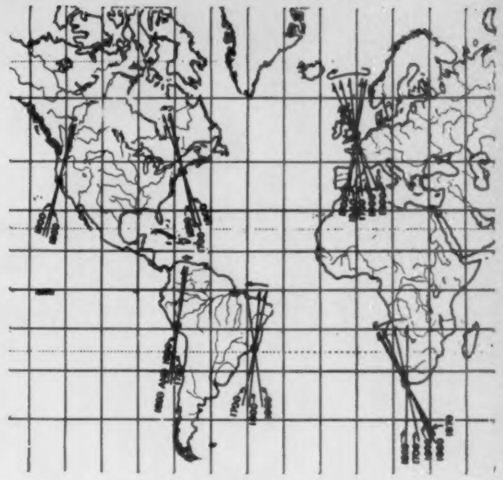
For this reason, especially at sea, it is not considered good practice to rely solely upon the deviation chart. From time to time, the navigator checks his compass by whatever means is available. Our interest is chiefly in the astronomical method, which my own experience has proven to be the most accurate.

The procedure is simple enough. The instrument used is the pelorus, a dummy compass equipped with sights, with which the bearing of a celestial body may be observed. There are two methods of observation in common practice. The first is to set the dummy compass card of the pelorus to correspond with the reading of the ship's master compass, then to sight the object. The bearing obtained is the same as that which would have been observed with the master compass itself, and is subject to **all** the errors of the compass.

If the object's true bearing, the azimuth, is known, a comparison with the observed position will yield the total compass error immediately. The variation is known from the charts of that region, and the residual error must be the deviation of the compass on that heading. This is the great value of celestial azimuths: the error is found as it actually exists on the heading being sailed. Even if the local variation is unknown, the course may be corrected according to the total compass error.

An alternate method of observing is to set the zero of the dummy compass card on the fore-and-aft line of the pelorus, a line corresponding to the longitudinal axis of the ship and known as the lubber line. Then the bearing observed will be the bearing of the body relative to the ship's head. If, at the same time, the master compass is read, its reading, added to the relative bearing, will give the required compass bearing of the body.

This would seem, at first glance, unnecessarily complicated, but it is actually more accurate than the first method, in which it is assumed that the helmsman or pilot will hold the same compass heading as that set on the pelorus until the observation is complete. This is difficult to achieve, and the instantaneous reading of the master compass outlined in the second method is therefore to be preferred.



The change in the direction of magnetic north for different places on the earth has been observed for some time, but its cause is not well understood.

As for working out the sight, there are several tables and methods available. Dutton describes the formulae and use of the Hydrographic Office **Red** and **Blue Azimuth Tables,** in which the latitude, meridian angle, and declination are considered known. However, in the absence of such tables, or failing to know the latitude (1) or the meridian angle (2), the following fundamental formulae are useful:

(1) $\sin \mathbf{Z} = \cos \mathbf{d} \sin \mathbf{t} \sec \mathbf{h}$

(2) $\cos \mathbf{Z} = \dfrac{\sin \mathbf{L} \sin \mathbf{h} - \sin \mathbf{d}}{\cos \mathbf{L} \cos \mathbf{h}}$

Here, **t** is the hour angle, **L** the latitude, **d** the declination, **Z** the azimuth, and **h** the altitude. It should be noted that in the first equation the latitude need not be known, while in the second the hour angle is not known.

In some tables of azimuth, the arguments are the altitude and the latitude, but in the newer ones, the arguments are meridian angle and latitude, since they are also designed to yield the computed altitude. In days gone by, however, when the average navigator had not yet begun to use the "new navigation," the azimuth was required only for compass checking, and the altitude was not given in the tables. In those days there was diversity of opinion as to which method was better. That may seem strange, but with the old-fashioned almanacs it probably took more time to figure out the hour angle of a body than to take a quick and approximate altitude.

In 1900, Capt. Lecky wrote: "Letters from quarter-deck friends prove that some prefer the **Time** method, and some the **Altitude** method of dealing with Azimuths —evidently great minds don't **always** think alike—just as some say 'Scotch' and others 'Irish' when invited to 'splice the main brace.' However, users of the G. U. Tables can now take their choice (of methods) and be happy."

I'm sure I would have enjoyed knowing Capt. Lecky! S.S.

OBSERVER'S PAGE

By Jesse A. Fitzpatrick

All times mentioned on the Observer's Page are Eastern war time.

Sunspot Observing

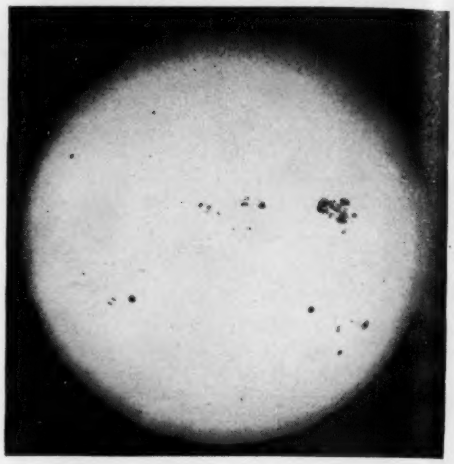
OWNERS of small telescopes will find that the observation of sunspots adds to their knowledge of interesting and instructive astronomical data. The number of spots should now be increasing, from the minimum of the 11-year cycle, last year and this year, to the maximum four or five years hence. Photographing and measuring the length and breadth of the spots and timing their transits across the solar disk can easily be done with a homemade reflecting telescope or a 3-inch refractor.

Proper protection for the eyes is of such vital importance in this work that I feel only a word of warning is not sufficient. A considerable number of telescope eyepieces are fitted with dust caps which also act as sun shields. Other telescopes have special Herschelian or solar eyepieces. It is perfectly safe to employ these, and they are much better than overexposed photographic film.

The sun shields belonging to the eyepieces of my two refractors happen to fit, like the cover on a can, over the eyepieces of my binoculars. Just a few minutes are required to adapt the binoculars and to train them on the sun to see if any new spots are appearing. If a spot does show and is large enough to warrant further study, I then prepare my telescope and observe at leisure.

Photographic film or neutral-density filters must never be used in connection with the eyepiece. They belong in front of or near the objective. In March, 1940, when a group of sunspots was coincident with tremendous disturbances in radio, telegraph, and even telephone reception, I was at my tropical island home. For two days we were unable to get radio news from either England or the States. I had been watching the sunspot group for several days and had described to the other residents its relationship to the magnetic storm. Those at the local radio station, never having observed sunspots, phoned me to inquire if it were possible to see them through a small 6x or 8x spyglass.

I assured them it could be done, but warned them about using smoked-glass or photo-film protection. They employed the latter, but it was placed over the eyepiece instead of in front of the object lens, and exploded almost at the instant the sun was brought into focus. Fortunately, no harm resulted, because the observer had started to hand the glass to another person and the explosion occurred when the instrument was several inches away from his eyes.[1]



The sun on August 12, 1917, photographed at Mount Wilson Observatory. The large group of spots can be estimated as about 70,000 miles long—nearly 1/12 the apparent solar diameter.

If visual observing is done by looking in the direction of the sun, as in the case of the conventional refractor, it is well to further protect one's face and eyes by fastening a good-sized piece of rigid cardboard to the telescope tube. A tiny hole or slit is necessary to help locate the sun. However, the ideal way to make these observations is by using a diagonal, thereby avoiding looking directly at the sun. In this respect, the observation is similar to that made with an ordinary Newtonian reflector, in which the eyepiece is on the side of the tube.

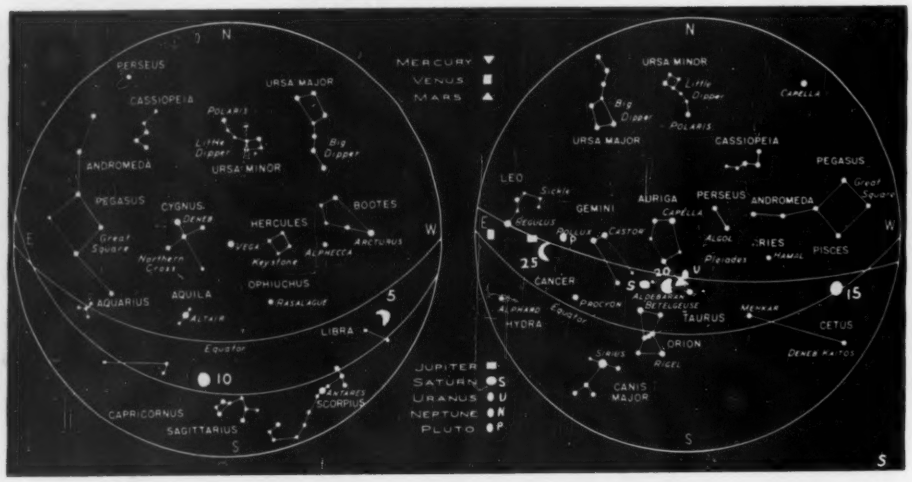
Instead of looking through the telescope while locating the sun with it, let the shadow cast by the telescope tube do the work. A little practice will enable the observer to know easily just when the sun is shining directly into the telescope.

Since the distance halfway around the sun near its equator is approximately 1,350,000 miles, and since the rotational speed in the same latitude is about 4,000 miles per hour, or 100,000 miles per day, a sunspot near the equator requires about 13½ days to travel from edge to edge of the apparent solar disk. (About half a day should be added to this because of the change in the earth's position during the interval, and additional time for the slower rotation of the sun for spots in higher latitudes.)

However, our line of sight near the solar limb is practically tangential, so that with a small telescope it is impossible to see a spot until at least a day

[1]For further experiences of this kind, see the letter from B. L. Harrell on page 14.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 6:30 a.m. on the 7th of the month, and at 5:30 a.m. on the 23rd. At the left is the sky for 8:30 p.m. on the 7th and for 7:30 p.m. on the 23rd. The moon's position is marked for each five days by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

The sun will arrive at the celestial equator, R.A. 12^h, at 6:12 p.m. on September 23rd. Autumn begins in the Northern Hemisphere, and spring in the Southern.

The equation of time will be 0^m on September 2nd, so on that day the sun will be due south at 1:00 p.m. war time at each of the standard meridians.

The moon, at full phase, will be near the vernal equinox on September 14th. This position is the most favorable for producing the phenomenon called the harvest moon.

Mercury is too near the sun for observation.

Venus passes inferior conjunction with the sun on September 5th (see special article in the July and August issues), and near the end of the month will be a brilliant object in the morning sky.

Mars, in Taurus, will be 1° 10′ south of Uranus on the 9th, and 4° 17′ north of Aldebaran on the 11th. It will be conspicuous in the sky at the end of the month, with a magnitude of —0.4.

Jupiter is in Cancer and Leo.

Saturn and **Uranus** are in Taurus. Uranus will start its retrograde motion on the 14th.

Neptune is too near the sun for observation.

after it has moved in from the eastern limb. From then on its progress can be observed in detail. The foreshortening lessens as the spot approaches the central meridian, enabling us to study the umbra and penumbra of the spot, the frequent change in shape and size, its breaking into smaller spots, and the occasional merging of many small spots into one or more larger ones. With a little practice, it is easy to estimate the approximate size of a single spot or the overall length of a group by making a comparison with the diameter of the sun's disk, 864,000 miles.

In this department, it is not possible to review all of the interesting information regarding the sun, sunspots, the solar rotation, and the correlation of solar activities with terrestrial disturbances, which the solar observer will want to know, but these facts can be easily found in any standard astronomy textbook.

A convenient and safe way to observe sunspots is to project the image of the sun through the eyepiece, focusing it on a black or white card held at a sufficient distance to produce an image of satisfactory size and clarity. Frames made of heavy wire designed to hold such a card may be purchased, or a homemade device can serve the same purpose. I have found it just as satisfactory, however, to place the card on the floor or a table below the telescope and to prop it up with anything handy to make it perpendicular to the telescope's tube and at the proper distance.

With each of my refractors there is a rectifying eyepiece, producing a magnification of 50x and a field of 40′ in the 3-inch, and magnification of 75x and field of 36′ in the 4½-inch. Since the diameter of the sun (and the moon) is about 30′, it can be entirely included and with a little to spare in either instrument. I use these eyepieces for all my occultation work and generally for sunspot observation and photography. The whole disk of the sun can be projected on the card as noted in the preceding paragraph. It is important to have the shielding card on the telescope's tube as large as possible in order to shut out the direct sunlight and thereby to obtain an image with good contrast.

This projected image can be photographed with good results, but, of course, exposure times and apertures depend on the type of camera and film. A few experiments are necessary. The card on which the image is projected should have a smooth surface, such as a piece of Bristol Board.

More experienced amateurs often photograph directly the image projected by the eyepiece. For this purpose, a Graflex camera, with its lens removed, is very suitable, because high shutter speed is attainable and the image can be seen just before the picture is taken. Filters can be used to lengthen exposures. The Rev. William M. Kearons, of Fall River, Mass., a noted amateur sunspot photographer, makes exposures which vary from 1/25 to 1/5 second, on Eastman Process film with Red A or Orange filters. (See **The Telescope**, May-June, 1940.)

The New York amateurs have built a long-focus solar camera with a high-speed shutter, primarily designed for eclipse work. The picture is taken in the focal plane, and the comparatively small image is subsequently enlarged from the negative. But for most amateurs, the other methods described here are much less difficult and, in practice, as satisfactory.

OCCULTATIONS—SEPTEMBER, 1943

Local station, lat. 40° 48′.6, long. 4^h 55.8^m west.

Date	Mag.	Name	Immersion	P.*	Emersion	P.*
Sept. 5	4.0	Gamma Librae	9:48.6 p.m.	91°	10:52.9 p.m.	290°
8	5.0	21 Sagittarii	9:06.8 p.m.	28°	9:47.8 p.m.	330°
8	7.4	BD −21° 5025	11:31.8 p.m.	146°		
10	6.1	Omicron Capricorni	9:29.0 p.m.	11°	10:00.0 p.m.	325°
17	5.9	BD +11° 455	11:14.1 p.m.	6°	11:42.8 p.m.	311°
19	6.0	179 B Tauri	1:04.1 a.m.	95°	2:06.8 a.m.	224°
25	6.5	227 B Cancri	5:23.9 a.m.	84°	6:36.5 a.m.	294°

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

PHASES OF THE MOON

First quarter ....September 7, 8:33 a.m.
Full moon.......September 13, 11:40 p.m.
Last quarter.....September 21, 3:06 a.m.
New moon ......September 29, 7:29 a.m.

LETTER TO THE EDITOR

Sir:

Sky and Telescope, August, 1943, page 22, 2nd column, line 8 from bottom of the page:

"Mars . . . will . . . at the end of the month (August) rise in the northwest . . . ."

Do you wanna bet?

CHARLES D. HUMBERD, M.D.
Barnard, Mo.

No bet. — ED.

★ ★

PLANETARIUM NOTES

***Sky and Telescope* is official bulletin of the Hayden Planetarium in New York City and of the Buhl Planetarium in Pittsburgh, Pa.**

★ THE BUHL PLANETARIUM presents in *September*, EVERY MAN A WEATHERMAN.

Most people's personal contacts with some sciences are rare, but not with the science of weather. The laboratory of the meteorologist is the air we breathe and the sky above us. In war time each of us must be his own weather prophet, and this month the Buhl Planetarium presents visually in its man-made sky a large number of weather signs and portents we all can use, enabling us to distinguish between true and false. The prime role of different types of clouds in foretelling the weather is featured. And we discover that while some of the time-honored weather adages are still good weather science today, others are not to be trusted.

★ THE HAYDEN PLANETARIUM presents in *September*, SAILING THE SEVEN SEAS. (See page 9.)

In *October*, THE SOUTHERN SKY. Today more than ever before we are conscious of the fact that we do not see all of the sky. There are stars strange to us, and visible to our good neighbors to the south. The boys serving in the armed forces in the Southern Hemisphere see stars that we do not. During October, you will take a trip "down under" to see the southern sky.

★ SCHEDULE BUHL PLANETARIUM

Mondays through Saturdays (except Tuesdays)........3 and 8:30 p.m.
Sundays and Holidays........3, 4, and 8:30 p.m.
(Building closed Tuesdays)

★ STAFF—*Director*, Arthur L. Draper; *Lecturer*, Nicholas E. Wagman; *Manager*, Frank S. McGary; *Public Relations*, Robert F. Hostetter; *Chief Instructor of Navigation*, Fitz-Hugh Marshall, Jr., *Instructor, School of Navigation*, Edwin Ebbighausen.

★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays........2, 3:30, and 8:30 p.m.
Saturdays ....11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays and Holidays........2, 3, 4, 5, and 8:30 p.m.

★ STAFF—*Honorary Curator*, Clyde Fisher; *Curator*, William H. Barton, Jr.; *Associate Curator*, Marian Lockwood; *Assistant Curator*, Robert R. Coles (on leave in Army Air Corps); *Scientific Assistant*, Fred Raiser; *Lecturers*, Charles O. Roth, Jr., Shirley I. Gale, John Saunders.